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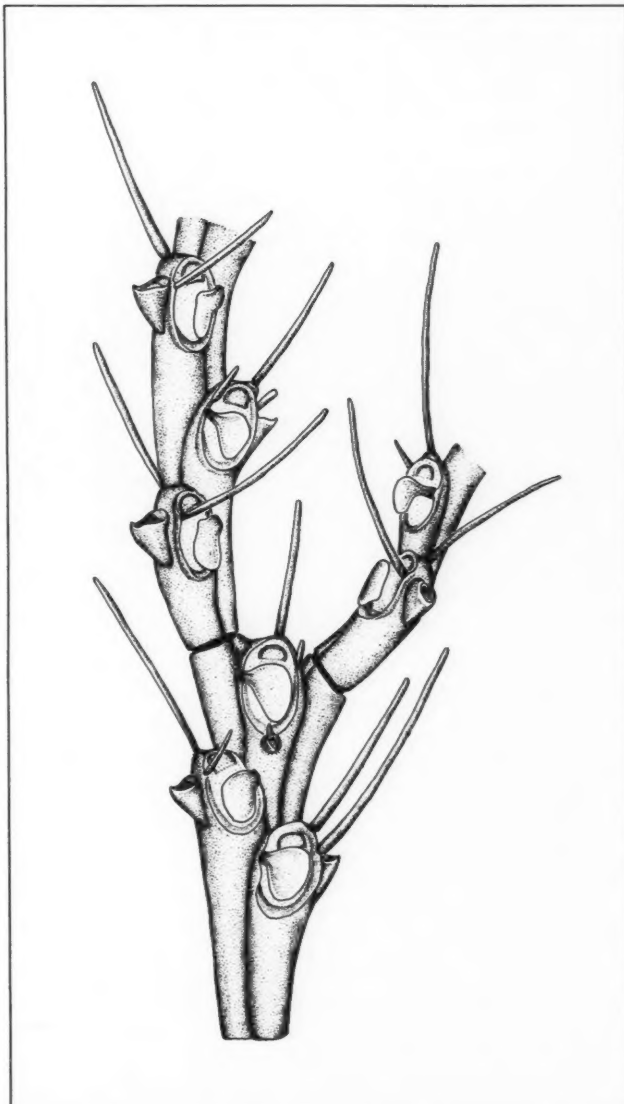
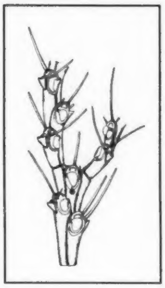


MARINE FLORA AND FAUNA OF THE EASTERN UNITED STATES

Marine Fisheries REVIEW



On the cover: *Tricellaria gracilis*, Figure 43 from NOAA Technical Report NMFS 99, "Marine Flora and Fauna of the Northeastern United States: Erect Bryozoa," by John S. Ryland and Peter J. Hayward.

Articles *58(3) 1996*

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History of a Systematics Odyssey: The Marine Flora and Fauna of the Eastern United States

MELBOURNE R. CARRIKER

On an early fall day in September 1962 I sat quietly, thoughtfully, at my large desk in a newly renovated corner office in the old Crane wing of the Lillie Building, Marine Biological Laboratory (MBL), Woods Hole, Massachusetts. Looking out through high, ancient windows, I could see the busy main street of Woods Hole in the foreground, Martha's Vineyard beyond, behind me the MBL Stone Candle House, across the street the Woods Hole Oceanographic Institution (WHOI) and to the far right, the Biological Laboratory of the Bureau of Commercial Fisheries (BCF)[1] (Fig. 1). Down the inner hall from my office stretched renovated quarters for the fledgling, ongoing, year-round MBL Systematics-Ecology Program (SEP), which I had been invited to direct.

Where to begin? My desk top was empty. No one else had yet been recruited to the promising adventure: still only a plan on paper. There were objectives needing further focus, personnel to recruit, field and laboratory facilities (beyond those of the MBL) to establish, and contacts with neighboring New England universities to institute. It was, in truth, a lonely, but exhilarating moment! Thus began the fast-paced, demanding SEP directorship.

I was informed of the opening of the SEP directorship by Philip B. Armstrong, Director of MBL, who wrote me on October 23, 1961:

Melbourne R. Carriker, now with the College of Marine Studies, University of Delaware, Lewes, DE 19958, was the founding editor of the Marine Flora and Fauna publication series and continues in that capacity.

[1]The BCF was then a part of the Interior Department's U.S. Fish and Wildlife Service. Since 1971, it has been the National Marine Fisheries Service under the Commerce Department's National Oceanic and Atmospheric Administration.

Figure 1.—Aerial view of the Woods Hole scientific community, ca. 1966. Today the Woods Hole Oceanographic Institution campus is extended some 2 km northeast to the Quissett Campus off Woods Hole road. Photograph by M. R. Carriker.

"The Marine Biological Laboratory, which is primarily a summer operation, is planning to embark on a year-round activity in marine systematics and ecology. The systematics segment of this program will be financed by a grant [$75,000] which the Laboratory has been awarded by the Ford Foundation. Would you by chance be interested in exploring this possibility with us?"

At the time I was serving as Chief of the Shellfish Mortality Program of the Biological Laboratory, Bureau of Commercial Fisheries, at Oxford, Md. Armstrong's letter came at a propitious moment. I was discouraged by the unresponsiveness of the Bureau to my requests to increase the personnel and enhance the research facilities of the Shellfish Mortality Program. Both were urgently needed to combat such bivalve diseases as MSX in the waters of the Chesapeake Bay. These circumstances, the proposed SEP, the allure of Woods Hole, and my desire for a professional change, tentatively framed my response.

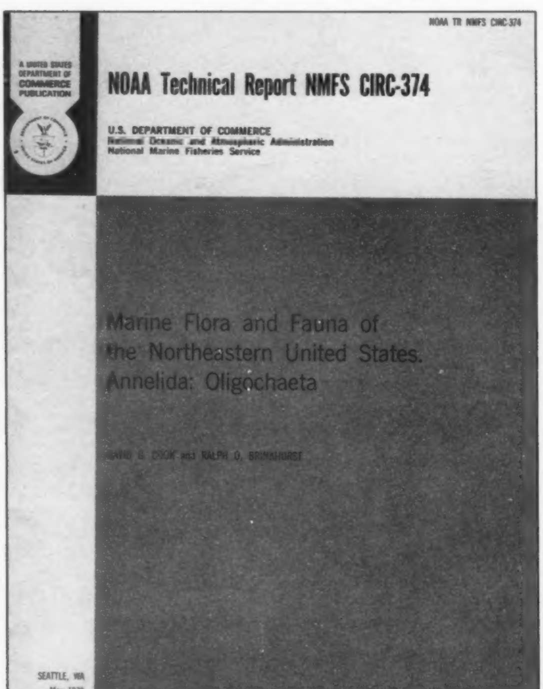
There followed a meeting with Armstrong and Arthur K. Parpart (Vice President, later President of the MBL Corporation) at Princeton University, to discuss the proposed program; and shortly thereafter, a brief visit to Woods Hole and Falmouth, Massachusetts, with my wife, Meriel ("Scottie") and four sons, Eric, Bruce, Neal, and Robert, to explore at firsthand the new MBL position and living conditions on Cape Cod. Needless to say, I was impressed with the opportunity offered me, and expressed an interest in exploring it.

On March 28, 1962 Parpart wrote me:

"At a meeting of the Executive Committee of the Marine Biological Laboratory held on March 16, 1962 it was voted to appoint you to serve as Director of the Systematics-Ecology Program at the Laboratory. We sincerely hope that you will accept this position and the responsibility that goes with it. The appointment will become effective on September 1, 1962 at an annual salary of $12,500."

Four days later, enthusiastically but with some trepidation, I accepted Parpart's invitation. However, as the future course of events demonstrated, I need not have been disquieted. Begun as a long-range experiment, SEP in many ways was a highly successful one. A major, and the most enduring project of SEP, which continues to this day, is the "Marine Flora and Fauna" series of scientific reports issued by the National Marine Fisheries Service (NMFS) Scientific Publications Office (SPO) as a subseries of that agency's peer-reviewed Technical Reports series (Fig. 2, 3). Closure of SEP, after 10 full, crowded years, came about, not for want of merit, but because of dwindling foundational support, especially for systematics.

Although eager to start my new job, particularly in the stimulating intellec-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NOAA Technical Report NMFS CIRC-374

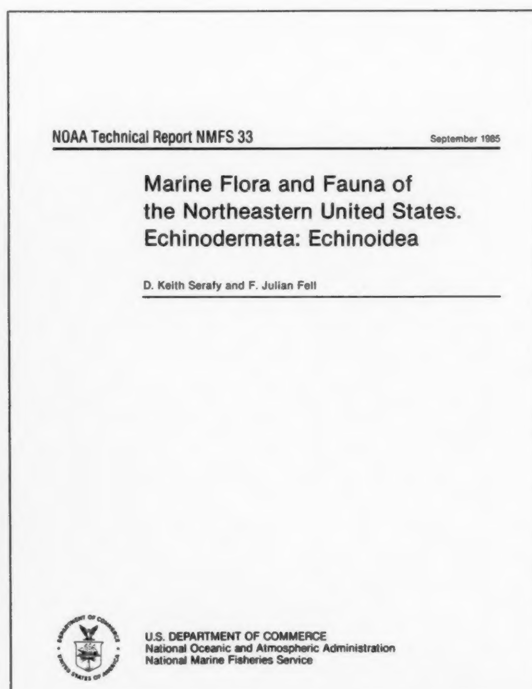
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Marine Flora and Fauna of the Northeastern United States. Annelida: Oligochaeta

DAVID G. COOK and RALPH O. BRINKHURST

SEATTLE, WA
May 1973

Figure 2.—Cover page of the first MFF manual to appear in print as a NOAA Technical Report NMFS Circular, 1973.


NOAA Technical Report NMFS 33 September 1985

Marine Flora and Fauna of the Northeastern United States. Echinodermata: Echinoidea

D. Keith Serafy and F. Julian Fell

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Figure 3.—Cover page of the first MFF manual to appear in print as a NOAA Technical Report NMFS, in 1985.

tual environment of the Woods Hole scientific community in the summer, I had some concerns. I was troubled by the potential impermanence of the proposed grant-financed SEP operation, the competition for space at MBL during the congested three summer months when most visiting scientists and their students were present, the low salaries of MBL personnel, and (as I soon learned) the often disparaging attitude toward whole-organism biology, especially biosystematics, by many of the visiting biochemical-molecular-cellular oriented biologists. I was also concerned about the mainly empty laboratories during the winter months. During SEP's first year or two from September to May, the Program was the principal, though minuscule, scientific activity at MBL. Essentially, we had the run of the physical facilities, library, chemistry stockroom, machine shop, biological supply services, and conference rooms pretty much to ourselves. On the whole, but for SEP, the MBL was an inactive, quiet place during the period October through April. We felt as though we were rattling around in an over-sized building. In time, however, to our advantage and stimulation, the MBL became increasingly active as the administration seriously promoted the use of its nonsummer facilities and services for research and training by independent investigators and groups of researchers. The Boston University Marine Program was one of the latter. Unquestionably, the year-round research and training in SEP benefitted the promotion. In the interim, our SEP isolation was warmly compensated by the full, year-round professional activities of the nearby WHOI and BCF.

For several years prior to the establishment of SEP, the MBL administration had been considering the need to assess further the local marine plant and animal resources of the Cape Cod area, the region from whence these organisms were collected for investigators and teachers at the laboratory. Early monitoring efforts in the 1950's involved Donald J. Zinn and John S. Rankin, Jr., who served consecutively as resident biologists. This was at a time when populations of the common purple sea urchin, *Arbacia punctulata*, popular especially for embryological research at MBL, were heavily harvested and dangerously depleted. It goes without saying that the willing efforts of the two resident biologists were only minimally successful. Obviously, the enormity of the task far exceeded their energy and resources. Ironically, some years later—in the late 1960's—the populations of *A. punctulata* returned, perhaps simply a peak in a population fluctuation?

This was the backdrop that led to the establishment of SEP. In brief, the task before us was to conduct a long-range, year-round, broad-based inventory of the estuarine-marine flora and fauna of the Cape Cod region (Fig. 4), and on this biosystematic foundation to superimpose basic investigations and foster advanced training in biosystematics and ecology.

As I paused in my new office in the Lillie Building on that September day in 1962, I began more seriously to appreciate the enormity of the work ahead. The only collection of local organisms, the George M. Gray Museum in Candle House, was small and in poor condition. Principal knowledge of local organisms lay unrecorded in the mental computers of MBL Collector Milton Gray and the Manager of the MBL Supply Department, John J. Valois. Other than a few mimeographed keys for local taxa, prepared for teaching purposes by the MBL marine ecology course staff, no identification manuals, catalogs, or lists of published systematic works existed. Among scientists in the neighboring WHOI and the BCF Woods Hole Laboratory (WHL), there were a few systematically oriented, established investigators, including Howard Sanders of WHOI and Roland Wigley of the BCF Laboratory. They, however, were busy with their own biological research programs generally away from Woods Hole.

Because the title "Systematics-Ecology Program" included "systematics" as well as "ecology," we understandably gave careful thought to the role of systematics in SEP, the marine biological sciences, and marine fisheries. As I reviewed the biosystematic literature in the large, comprehensive MBL Library, it became abundantly clear that biosystematics (the study of the diversity of organisms) and taxonomy (the theory and practice of classifying) continue to be of pivotal importance in much of both fundamental and applied biology (Mayr, 1969). For one thing, the immensity of the diversity of organisms in the living world is staggering, a complexity impossible to deal with, if not ordered and classified (Mayr, 1969). For another, identification of organisms gives access to stored systems of biological information (all published knowledge on organisms is cataloged and assembled under the scientific names of species in the world scientific literature). Indisputably, accurate retrieval of this information can only be as reliable as the precision exercised in the original identification and classification. It follows undeniably that increasing refinement and quantification of the results of biological investigation will require comparable exactness in identification of the organisms involved. This applies to both basic and applied research. Imprecision in taxonomy will neutralize whatever rigor was applied in the research; if identifications are in error, reports and published works on them will be nonreplicable and correspondingly unreliable (Carriker, 1976b).

Nonspecialists are usually able to identify and classify species only after these species have been described, named, and properly reported in the technical literature. Owing to the difficulty of use of this literature by nonspecialists, systematists often synthesize the original literature into a form that is more readily applied. Manuals in the "Marine Flora and Fauna" subseries (Fig. 2, 3) are of this form. In this context, Mayr (1968) noted:

"Taxomists supply a desperately needed identification service for taxa of ecological significance . . . In all areas of applied biology good taxonomy is indispensable . . . Much work in conservation, wildlife management, and the study of renewable natural resources of all kinds depends for its effectiveness on the soundness of taxonomic research. The faunas, floras, handbooks, and manuals prepared by taxonomists are indispensable in many branches of

biology and also widely used by the general public."

Serious problems arise from inaccurate identification of biological species. This is evidenced by an excess of examples in the scientific literature. Especially troublesome are marine species similar in external appearance, but dissimilar physiologically or ecologically. Not uncommonly, this results in both basic and applied research being repeated unnecessarily, because identifications of organisms in the original investigation were in error, or because the researcher did not consult the systematic literature or museum collections with sufficient thoroughness.

A case in point is that of wood-boring bivalves found in the warm-water discharge canal of a nuclear generating station in New Jersey. An investigator, identifying them only to generic level, concluded they were indigenous. Ruth Turner, Museum of Comparative Zoology, Harvard University, was later requested to check the identification, and

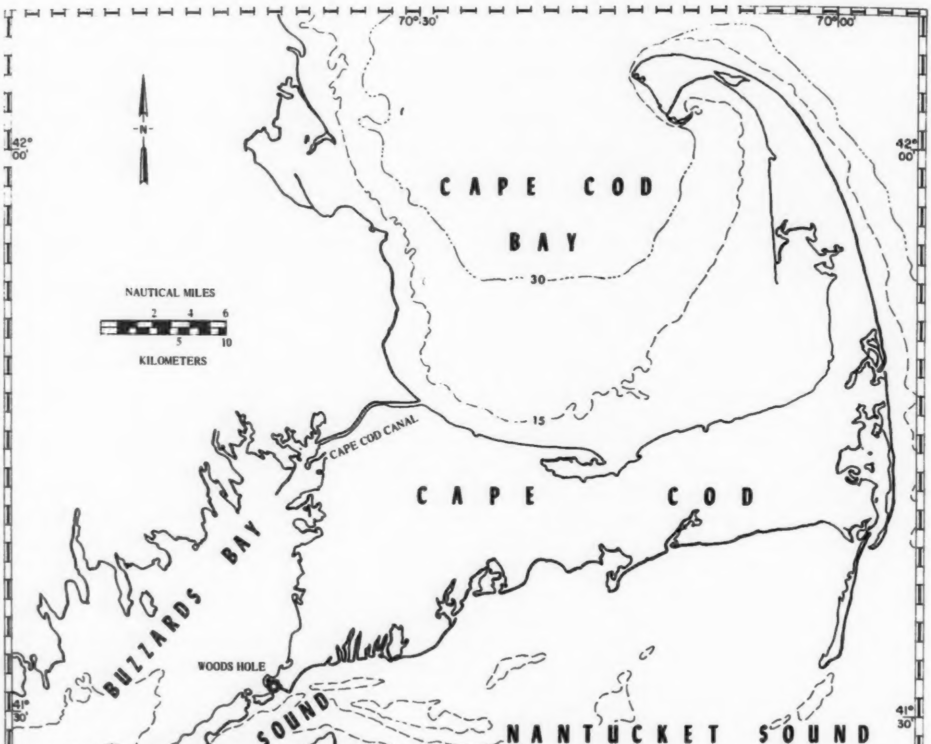


Figure 4.—The Cape Cod region, area of operation of the MBL Systematics-Ecology Program.

to her surprise discovered that the bivalves were an introduced tropical species (personal commun.)!

A second example concerns certain species of marine planktonic dinoflagellates that in massive concentrations sometimes produce "red tides" in coastal waters. These species, in such genera as *Gonyaulax* and *Gymnodinium*, produce toxins in some species of bivalves living in the red tide seawater that are fatally toxic to man (Dale and Yentsch, 1978); other species of dinoflagellates do not.

Libraries, unavoidably, retain many examples of results of expensive research discredited because of faulty or incomplete identification of the species utilized. Michener et al. (1970) stressed that underlying all important biological work is knowledge of the identity of the species and its position in the ecosystem, and that without this basic information it is doubtful that any major advances could have been made in biology. According to Blackwelder (1967) systematics must precede all other forms of biological investigation and necessarily furnishes the foundation and frame upon which the results of researches on all the natural sciences can be built.

In addition to the pivotal significance of theoretical systematics to biology, I soon rediscovered in my review that systematics contributes significantly to the solution of practical fisheries problems. The much admired systematist, Waldo L. Schmitt (1967), Smithsonian Institution, related two such examples. In the first, a specialist on sipunculid worms was asked for copies of his publications by an Alaskan cod fisherman. This man had observed that wherever these worms occurred, he always made good hauls of finfish. He therefore planned to plot the distribution of the worms in order to extend his fishing operation. In a second example, a fisherman sought information on the habits, distribution, and abundance of a certain species of crustacean that he had captured during recreational fishing. A specialist identified the species as a stomatopod, a favorite food of desirable panfish caught by fishermen in the Chesapeake Bay area.

On a broader organizational fisheries level, Collette and Vecchione (1995), while emphasizing the need for practical identification manuals for use by fishery scientists in the field, underscored the importance of increased interaction between systematists and fishery scientists. Such cooperation, they explained, would permit systematists to obtain biological specimens for study and concurrently help fishery scientists resolve systematic problems of practical importance—such as, for example, the accurate identification of seafood species for the seafood industry. They suggest that existing fishery sampling programs could aid systematists in monitoring and understanding biological diversity by expanding collecting efforts at relatively little additional cost. The resulting vouchered specimens would record the distribution of these species and could be used in critical baseline studies of heavy metal, pesticide, and parasite levels in the ecosystems of their origin.

Although the field of ecology was generally accepted by many summer biologists at MBL as an "emerging science" (but yet far down the pecking order), the majority delegated biosystematics to the bottom rung of the hierarchy. This attitude surprised most of us in SEP in view of the important pioneering field studies carried out many decades earlier by Verrill et al. (1873) and Sumner et al. (1913) in southern New England coastal waters—the veritable "backyard" of Woods Hole! In spite of this disinterested prevailing opinion, we determined to consider biosystematics on a par with ecology, giving equal emphasis to both fields. The theoretical and practical significance of biosystematics, the increasing national awareness of the growing number of known endangered biological species, and the accelerating destruction of habitats around the world (Carriker, 1967b) led us to this decision. The Cape Cod region would not escape the pressure: popular with summer visitors and growing rapidly, it would undoubtedly experience pillaged habitats in the future. By the early 1960's we had reached the conclusion, so eloquently phrased much later by Peter Raven (1990), that the crisis of biodiversity has become a cardinal concern, and description and documentation of "the grand pattern of life on earth," while still possible to accomplish on a broad scale, is supremely important. First field studies by SEP investigators soon demonstrated clearly that a knowledge of the kinds and groupings of organisms (biosytematics) is of fundamental importance in the accurate interpretation of the biotic patterns evolving in the Cape Cod marine ecosystem and in deciphering the levels of ecological integration of populations in the region.

And so the work of getting SEP underway began. In the beginning, I and my new secretary San Lineaweaver, running seawater troughs, and much empty laboratory space, occupied principally the second floor of a wing of the Crane building with partially remodeled Candle House next door as an annex. First to join me shortly after I arrived were Victor A. Zullo, postdoctoral fellow; Henry D. Russell, curator; Dennis J. Crisp, visiting investigator from the University College of North Wales; and José Squadroni, s.j., visiting investigator from Montevideo, Uruguay. Growth of the SEP group was rapid. By the end of the first year, the number of full- and part-time personnel reached 24. About half of these were involved in biosystematics.

Traditionally, MBL services had been geared primarily to support laboratory research and teaching, organisms being collected in the Cape Cod region and brought to MBL investigators by collectors in the MBL Supply Department. As SEP developed—because systematics-ecological research generally requires investigators to enter the field to collect, observe, and experiment with plants and animals in their native environment—we added special facilities and personnel beyond those available to us through MBL. These included the 65-foot R/V *A. E. Verrill* (Fig. 5), small boats and vehicles, scuba facilities, biotic reference collections in the Gray Museum, aerial and underwater biophotography, sampling and monitoring gear, crew for boats, and a technologist to work with investigators and students in the field. These were all funded by grants and contracts to SEP.

Figure 5.—The R/V *A. E. Verrill* was launched formally late in 1966 and became the workhorse of the Systematics-Ecology Program. Funded by the Ford Foundation and constructed for the Program, the ship is 64 feet 11 inches long. It has a large main research laboratory with running fresh and seawater for processing samples, and an over-the-stern facility for collection of samples by means of a moveable gantry.

During our first year, we retrieved and incorporated the deteriorating remnants of the original Gray biotic collections in the new SEP Gray Museum in Candle House. In February 1970, SEP and the Gray Museum were moved to spacious new quarters in the new MBL Loeb building across the street from Lillie (Fig. 1). The Museum collections were located in a large space on the lower floor of Loeb[2]. Computer facilities and electron microscopes were available at WHOI, where personnel were cordial and generously cooperative.

Ultimately, the maximal size of the SEP staff was that which could be accommodated year-round in the facilities set aside for SEP by the MBL administration; this size, in turn, was limited by the space requirements of the growing visiting summer population of scientists and students. Because SEP funding was primarily from grants and contracts (over the decade from the Ford Foundation, the Grass Foundation, the Federal Water Pollution Control Administration, the National Science Foundation, the National Institutes of Health, Office of Naval Research, and Whitehall Foundation, among others), frequent changes occurred in SEP personnel, especially among the resident staff, who sooner or later obtained "permanent" positions elsewhere. During the SEP decade (1962–72), a total of 256 persons were associated with the Program: 20 resident investigators, 24 postdoctoral fellows and research associates, 23 graduate research trainees, and 42 visiting investigators; the remainder were support staff.

In addition to advancing knowledge of the marine organismic biology of the Cape Cod region by a resident research and support staff, SEP biologists served as a nucleus to 1) attract faculty and advanced students, primarily from New England colleges and universities, to conduct studies in association with the resident staff and 2) foster research training, communications, and experience in biosystematics, ecology, and related organismic disciplines. This milieu provided the impetus and an invaluable resource for the inception and early development of the "Marine Flora and Fauna" program and publications.

A major impediment to organismic studies in the Cape Cod region was the abysmal lack of adequate identification literature and reference collections. As the work of SEP investigators and students progressed, the coastal plant and animal reference collections in the Gray Museum grew apace. With the valued collaboration of visiting investigators, mainly from New England colleges and universities, our resident staff identified and classified an increasingly large number of specimens. This was a colossal task and a complex organizational problem for the curator of the Gray Museum, as well as for scientists and students undertaking regional biotic inventories. These were the major source of biological specimens.

These censuses included the intensive, quantitative analysis of the Cape Cod Bay ecosystem from the R/V *A. E. Verrill*; and investigations of smaller scale in Barnstable Harbor, Buzzards Bay, Hadley Harbor, Quicks Hole, Vineyard Sound, the intertidal zones and shallow water of the lower Cape and the nearby islands (Fig. 4). A total of 42 major algal, plant, and animal groups were examined during the SEP decade. Several new species were described, and the range of many more was extended. The majority of studies was on free-living benthic algae and animals, primarily macroalgae and invertebrates; a few were on parasites and commensals. A large part of SEP biosystematic research was necessarily descriptive, at the alpha level, owing to the plethora of gaps in the knowledge of the holistic biology of the Cape Cod region (Carriker, 1962–72).

Our earliest effort to fill the critical need for, and void in the identification literature of the Cape Cod region was enthusiastically and energetically spearheaded by Ralph I. Smith in 1963. He

[2]In 1993 the Gray Museum collections were awarded, through competitive proposals, to the Peabody Museum, Yale University, and were incorporated in the Peabody Museum collections. There they retain their identity in computerized records, and can be searched electronically on the World Wide Web Site (personal commun., Eric A. Lazo-Wasem, Collections Manager).

persuasively marshalled the collaboration of some 25 biologists at MBL (and some from elsewhere) who possessed systematic expertise. With their help he coordinated the preparation of and edited the valuable and still much used (but out of print) "Keys to Marine Invertebrates of the Woods Hole region" (Smith, 1964). With intensity but with good humor, Smith kept our faithful secretaries, Hazel Santos, San Lineaweaver, and Virginia Smith, busy and sometimes bewildered, as he organized and reorganized (no computers then) the contributions of collaborating systematists. [Secretary Eva Montiero, who remained with SEP until its close, did not join us until 1965.] In his "Editor's Preface", Smith (1964) noted "Relatively few present-day biologists realize the difficulties involved in identifying with certainty the myriad species of marine invertebrates. . . . Keys are useful mainly in the identification of common and obvious animals . . . something out of the ordinary should be referred to a specialist."

After publication of those "Keys," there followed the SEP works: "Marine and Estuarine Environments, Organisms and Geology of the Cape Cod Region, an Indexed Bibliography, 1665–1965" by Anne Yentsch et al. (1966); and publications of broad scope by SEP visiting investigators from other institutions: "The Triumph of the Darwinian Method" by Michael Ghiselin (1969), "Shallow-water Gammaridean Amphipoda of New England" by E. L. Bousfield (1973) with beautiful illustrations (Fig. 6) by Ruth von Arx [now deceased], and the "Ascidiacea of the Atlantic Continental Shelf of the United States" by Harold Plough (1978).

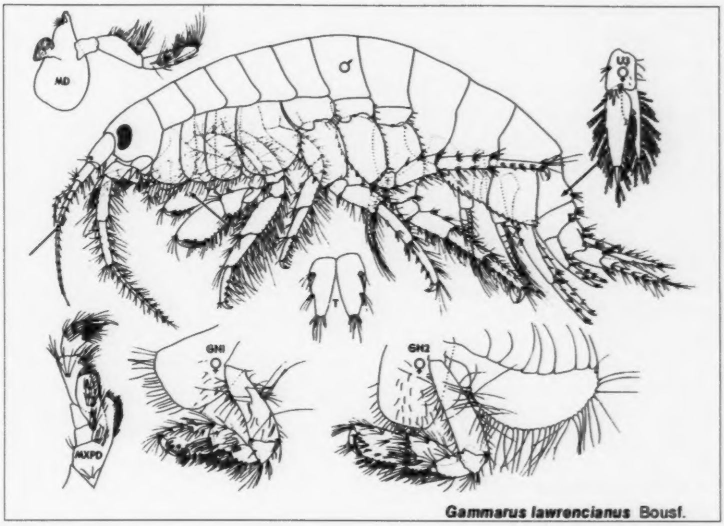


Figure 6.—A gammarid amphipod crustacean drawn by Ruth von Arx, Figure 2, p. 214, for Bousfield (1973).

Starting in early 1966, the hiatus in identification literature for the Cape Cod region, importantly though only partially, filled by Smith's "Keys," had prompted serious discussions among senior SEP investigators (primarily Ruth D. Turner, Robert T. Wilce, Victor A. Zullo, and I) on the need for a more comprehensive volume. It would be one, we hypothesized, that would include brief, illustrated, artificial couplet keys and related biological information on the estuarine and coastal marine plants and invertebrates of the New England area. These keys would complement existing as well as planned systematic monographs and handbooks, and be directed to undergraduate and graduate biology students and nonsystematic biologists.

By this time (1965), Smith's popular "Keys" was in need of updating with additional taxa. We were confident that the impressive recent contributions in marine biosystematics by biologists of the long established New England institutions and the substantial research accomplished by SEP investigators, with the support of the Gray Museum collections and continuing inventories in the Cape Cod region, would provide a significant systematic resource for the preparation of the proposed volume. Furthermore, the opportunity for visiting investigators to use SEP field facilities in cooperation with SEP staff and the services of the Gray Museum, would materially facilitate the research of collaborating systematists. Also possible, was collecting in cooperation with biologists in other New England institutions, such as, for example, the new marine station of Northeastern University at Nahant in Massachusetts Bay.

By early 1967, we had completed preliminary discussions and began serious planning of the systematic volume. I prepared a draft manuscript on a representative local taxon, and distributed it to several interested persons in SEP and in the Boston area. It soon became painfully clear, however, that a single volume accommodating all the ideas that were emerging would not be practical. For one thing, the proposed volume would include many systematic specialists, each probably completing his/her contribution at a different time, putting final publication years or decades away. For another, updating of sections of different taxa would not be possible without republication of the entire volume.

Realistically, then, the concept of a single volume had to be abandoned, and in its place a plan evolved for a series of manuals, each for a major taxon, appearing periodically as manuscripts were completed. The proposed series was initially named the "Marine Flora and Invertebrate Fauna of New England." This was subsequently shortened to the "Marine Flora and Fauna of New England" (MFF).

As planning of the MFF proceeded, there arose the sensitive questions as to the official address and institutional sponsorship (if any) of the series. A

potentially vexing problem was revealed earlier by E. L. Bousfield, visiting investigator in SEP and senior scientist, Museum of Natural Sciences, Ottawa, Canada, who commented casually one day that Ruth D. Turner, Museum of Comparative Zoology, Harvard University, and visiting investigator in SEP, and Nathan W. Riser, director, Marine Laboratory, Northeastern University, also had been thinking about preparing illustrated taxonomic keys to the marine organisms of the New England area.

To open the matter for discussion, I telephoned Turner. We agreed to call several meetings, alternating between Boston and Woods Hole, to talk over our suggested format and direction for the MFF and the Turner-Riser plan for keys. Those attending generally included Turner; Robert T. Wilce, Botany Department, University of Massachusetts and visiting investigator in SEP; Riser; I. MacKenzie Lamb, Director, Harvard University Farlow Reference Library and Herbarium of Cryptogamic Botany; William Randolph Taylor, Department of Botany, University of Michigan; Victor A. Zullo, resident systematist in SEP; and me. At the onset, we concurred that the official address of the MFF should be either the Harvard Museum of Comparative Zoology, or SEP-MBL, Woods Hole. Turner and the Boston Malacological Club strongly favored the Boston address, and Wilce, the SEP staff, and I equally strongly leaned toward the Woods Hole address. The strong systematic emphasis of the SEP Program, proximity and access to the Cape Cod marine-estuarine habitats, attractions of the Woods Hole scientific community, and the strong cooperative support we in SEP could provide, swung the decision in favor of Woods Hole. The weight of these arguments prevailed, and SEP was eventually chosen good-naturedly.

Figure 8.—Photograph of Robert T. Wilce, 1985.

Figure 7.—Photograph of Ruth Turner, 1957.

This matter peacefully resolved, we turned next to detailed planning on the MFF. An editorial board, consisting of Turner (Fig. 7), Wilce (Fig. 8), and me (Fig. 9), was formed. I consented to serve as coordinating editor. We concurred that this administrative board would function as an independent, nonprofit operation, responsible for the format, organization, financing, and publication of the MFF series.

Next, we developed a tentative format for a sample manual in the series that would be applicable generally to most taxa with minimal variation from taxon to taxon. Such a format, we reasoned, would make the manuals "user friendly." We defined the "Marine Flora and Fauna" as a series of original, illustrated manuals on the identification, classification, and general biology of coastal marine plants and animals, ranging from the headwaters of estuaries seaward to about the 200 m depth on the continental shelf; geographic distribution would vary with each major taxon treated and interests of authors. Each manual was to be based primarily on recent research and a fresh examination of organisms, where this was possible, and would be completed without a deadline, and published after due review by referees. Each manual would represent a major taxon and contain an introduction, illustrated glossary, uniform originally illustrated keys, annotated checklist with information when available on habitat, life history, distribution, and related biology, references to major literature of the group, a systematic index, and coordinating editor's comments. Manuals were intended for use by biology students, biologists, biological oceanographers, informed lay persons, and others wishing to identify coastal organisms in the region, and to serve as a guide to additional information about the species in the taxon. A version of this description appears in the "Foreword" to each of the published manuals.

These plans were well received by biologists. The format and plans for financing and publishing of the MFF were presented to and, following discussion of several questions on the fi-

Figure 9.—Photograph of Melbourne R. Carriker, 1968.

nancial aspects, approved by H. Burr Steinback, Director, MBL.

Following this, we prepared a sample manual on a well known taxon to send to potential collaborators in the "Marine Flora and Fauna." By 1969, Turner and Johanna Reinhart, Curator of the Gray Museum, had completed a draft manual consisting of an introduction to the Mollusca, an illustrated key to the classes of the Mollusca, and a partial illustrated key to shelled benthic gastropods, the detailed figures drawn by artist Ruth von Arx of Woods Hole. This draft was distributed to potential collaborators, systematists visiting SEP, and others in the New England region and elsewhere, with an invitation to consider preparing a manual of their choice. By this time (1969), some 4,725 copies of the Smith's (1964) "Woods Hole Keys" had been sold by the MBL Supply Department. This encouraged us, indicating something of the interest in, and need for this kind of systematic literature.

Response to our invitation was gratifying. By 1970, 45 collaborators had agreed to prepare manuals. That year, also, the first manual "Higher Plants of the Marine Fringe of Southern New England" by E. T. Moul (1973: Table 1, Fig. 10) appeared in preprint form, and preliminary drafts of manuals on the Tardigrada by L. W. Pollock (1976: Fig. 11), Oligochaeta by D. G. Cook and R. O. Brinkhurst (1973: Fig. 12), Ciliata by A. C. Borror (1973), and Kinorhyncha by R. P. Higgins were completed. [The Higgins draft has not yet been published]. Several other manuals were in various stages of preparation. That same year (1970), the National Science Foundation granted SEP-MBL $25,000 for 2 years of support specifically for preparation of manuals by collaborators. Additional support for the "Marine Flora and Fauna" had been available through SEP grants from the Ford Foundation and the National Science Foundation. In addition, some collaborators from other institutions provided partial support from their own grants.

At this time we also enlarged the Editorial Board of the MFF by inviting Marie B. Abbott, curator, Gray Museum (Fig. 13); Arthur G. Humes, Director, Boston University Marine Program at MBL (BUMP) (Fig. 14); Wesley N. Tiffney, Boston University Graduate School (Fig. 15); and Roland L. Wigley, Supervisory Fishery Biologist (Research), Woods Hole Laboratory, NMFS Northeast Fisheries Center (Fig. 16). These additions were made to more broadly represent the diverse categories of taxa being considered for inclusion in the MFF. Humes became associated with SEP in 1970 and later accepted the directorship of BUMP in cooperation with SEP. Manuscripts were reviewed by members of the Editorial Board of SEP and by outside referees. Revisions in those days were time consuming and a chore, as desktop computers, so common today, were not yet available.

By 1971, 75 systematic specialists were collaborating in the writing of manuals, and those by Borror, Cook and Brinkhurst, Moul, and McCloskey (Table 1) were essentially ready for final editing and publication. In December 1970, I sent courtesy copies of those manuals to Steinback in recognition of his kindness in helping us to initiate the MFF series. He kindly responded in a hand-written note: "Dear Mel: Many thanks for showing these to me. I'll come and borrow copies if I need them. Congratulations on the operation!"

In 1967, the Editorial Board had begun exploring possible commercial publication outlets for the "Marine Flora and Fauna." The first was through

Table 1.—List of taxa and authors of Marine Flora and Fauna manuals published and in press in the NOAA Technical Report NMFS series, 1973–1996. The NTIS[1] accession no. is given in parentheses ( ).

Marine Flora and Fauna of the Northeastern United States

Annelida: Oligochaeta. David G. Cook and Ralph O. Brinkhurst. 1973. NOAA Tech. Rep. NMFS CIRC-374, 23 p., 82 figs. (COM 73 50670).

Protozoa: Ciliophora. Arthur C. Borror. 1973. NOAA Tech. Rep. NMFS CIRC-378, 62 p., 193 figs. (COM 73 50888).

Higher plants of the marine fringe. Edwin T. Moul. 1973. NOAA Tech. Rep. NMFS CIRC-384, 60 p., 108 figs. (COM 74 50019).

Pycnogonida. Lawrence R. McCloskey. 1973. NOAA Tech. Rep. NMFS CIRC-386, 12 p., 39 figs. (COM 74 50014).

Crustacea: Stomatopoda. Raymond B. Manning. 1974. NOAA Tech. Rep. NMFS CIRC-387, 6 p., 10 figs. (COMS 74 50487).

Crustacea: Decapoda. Austin B. Williams. 1974. NOAA Tech. Rep. NMFS CIRC-389, 50 p., 111 figs. (COM 74 51194).

Tardigrada. Leland W. Pollock. 1976. NOAA Tech. Rep. NMFS CIRC-394, 25 p., 71 figs. (PB 257 987).

Cnidaria: Scyphozoa. Ronald J. Larson. 1976. NOAA Tech. Rep. NMFS CIRC-397, 18 p., 28 figs. (PB 261 839).

Higher Fungi: Ascomycetes, Deuteromycetes, and Basidiomycetes. A. Ralph Cavaliere. 1977. NOAA Tech. Rep. NMFS CIRC-398, 49 p., 125 figs. (PB 268 036).

Copepoda: Harpacticoida. Bruce C. Coull. 1977. NOAA Tech. Rep. NMFS CIRC-399, 48 p., 100 figs. ((PB 268 714).

Sipuncula. Edward B. Cutler. 1977. NOAA Tech. Rep. NMFS CIRC-403, 7 p., 6 figs. (PB 273 062).

Echinodermata: Holothuroidea. David L. Pawson. 1977. NOAA Tech. Rep. NMFS CIRC-405, 15 p., 55 figs. (PB 274 999).

Copepoda: Lernaeopodidae and Sphyriidae. Ju-Shey Ho. 1977. NOAA Tech. Rep. NMFS CIRC-406, 14 p., 16 figs. (PB 280 040).

Copepoda: Cyclopoids Parasitic on Fishes. Ju-Shey Ho. 1978. NOAA Tech. Rep. NMFS CIRC-409, 12 p., 17 figs. (PB 281 969).

Crustacea: Branchiura. Roger F. Cressey. 1978. NOAA Tech. Rep. NMFS CIRC-413, 10 p., 15 figs. (PB 222 923).

Protozoa: Sarcodina: Amoebae. Eugene C. Bovee and Thomas K. Sawyer. 1979. NOAA Tech. Rep. NMFS CIRC-419, 56 p., 77 figs. (PB 285 538).

Crustacea: Cumacea. Les Watling. 1979. NOAA Tech. Rep. NMFS CIRC-423, 23 p., 35 figs. (PB 296 460).

Arthropoda: Cirripedia. Victor A. Zullo. 1979. NOAA Tech. Rep. NMFS CIRC-425, 29 p., 40 figs. (PB 297 676).

Cnidaria: Scleractinia. Stephen D. Cairns. 1981. NOAA Tech. Rep. NMFS CIRC-438, 15 p., 16 figs., 2 tables (PB 124 520).

Protozoa: Sarcodina: Benthic Foraminifera. Ruth Todd and Doris Low. 1981. NOAA Tech. Rep. NMFS CIRC-439, 51 p., 324 figs. (PB 225 053).

Turbellaria: Acoela and Nemertodermatida. Louise F. Bush. 1981. NOAA Tech. Rep. NMFS CIRC-440, 71 p., 184 figs. (PB 219 387).

Lichens (Ascomycetes) of the Intertidal Region. Ronald M. Taylor. 1982. NOAA Tech. Rep. NMFS CIRC-446, 26 p., 43 figs. (PB 124 735).

Echinodermata: Echinoidea. D. Keith Serafy and F. Julian Fell. 1985. NOAA Tech. Rep. NMFS 33, 27 p., 42 figs. (PC A03/MF A01).

Echinodermata: Crinoidea. Charles G. Messing and John H. Dearborn. 1990. NOAA Tech. Rep. NMFS 91, 30 p., 18 figs. (PB 86 156 395).

Erect Bryozoa. John S. Ryland and Peter J. Hayward. 1991. NOAA Tech. Rep. NMFS 99, 48 p., 69 figs.

Marine Flora and Fauna of the Eastern United States

Cephalopoda. Micheal Vecchione, Clyde F. E. Roper and Michael J. Sweeney. 1989. NOAA Tech. Rep. NMFS 73, 23 p., 29 figs. (PB 89 189 583).

Copepoda, Cyclopoida: Archinotodelphyidae, Notodelphyidae, and Ascidicolidae. Patricia L. Dudley and Paul L. Illg. 1991. NOAA Tech. Rep. NMFS 96, 40 p., 47 figs., 2 tables.

Dicyemida. Robert B. Short. 1991. NOAA Tech. Rep. NMFS 100, 16 p., 39 figs.

Anthozoa: Actiniaria, Zoanthidea, Corallimorpharia and Ceriantharia. Kenneth P. Sebens. In press.

Platyhelminthes: Monogenea. Sherman S. Hendrix. In press.

Acanthocephala. Omar M. Amin. In press.

[1] National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. NTIS sells copies of the manuals in either microfiche or hard (xerographic) copy form.

Juncus balticus

Erect herbs with slender cylindrical stems; basal leaves reduced to bladeless sheaths; rhizomes firm, extensively forked; along brackish shores and margins of tidal marshes.

Figure 107.—(a) Habit sketch; (b) sheathing basal leaves × 1/10.

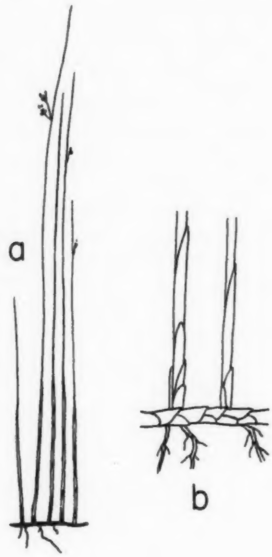


Figure 10.—A marsh juncus, Figure 107, p. 43, from Moul (1973), Ruth von Arx illustrator.

39 (*38*) Caudal ala deeply sculptured and nearly divided; lateral alae divided . . . . ***Florarctus heimi***

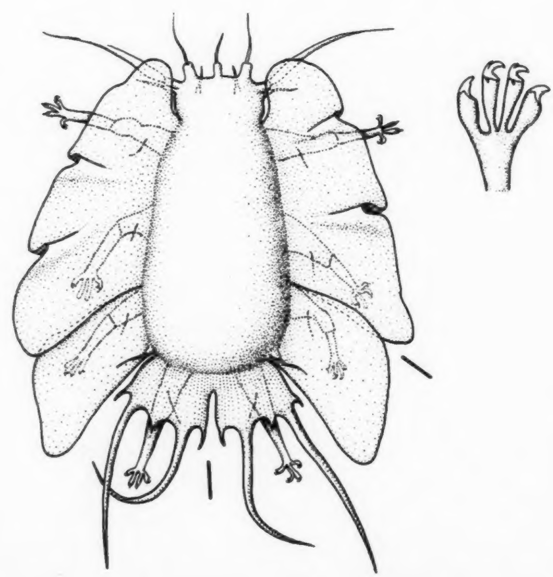


Figure 11.—A tardigrade metazoan, at couplet 39(38), p. 18, from Pollock (1973).

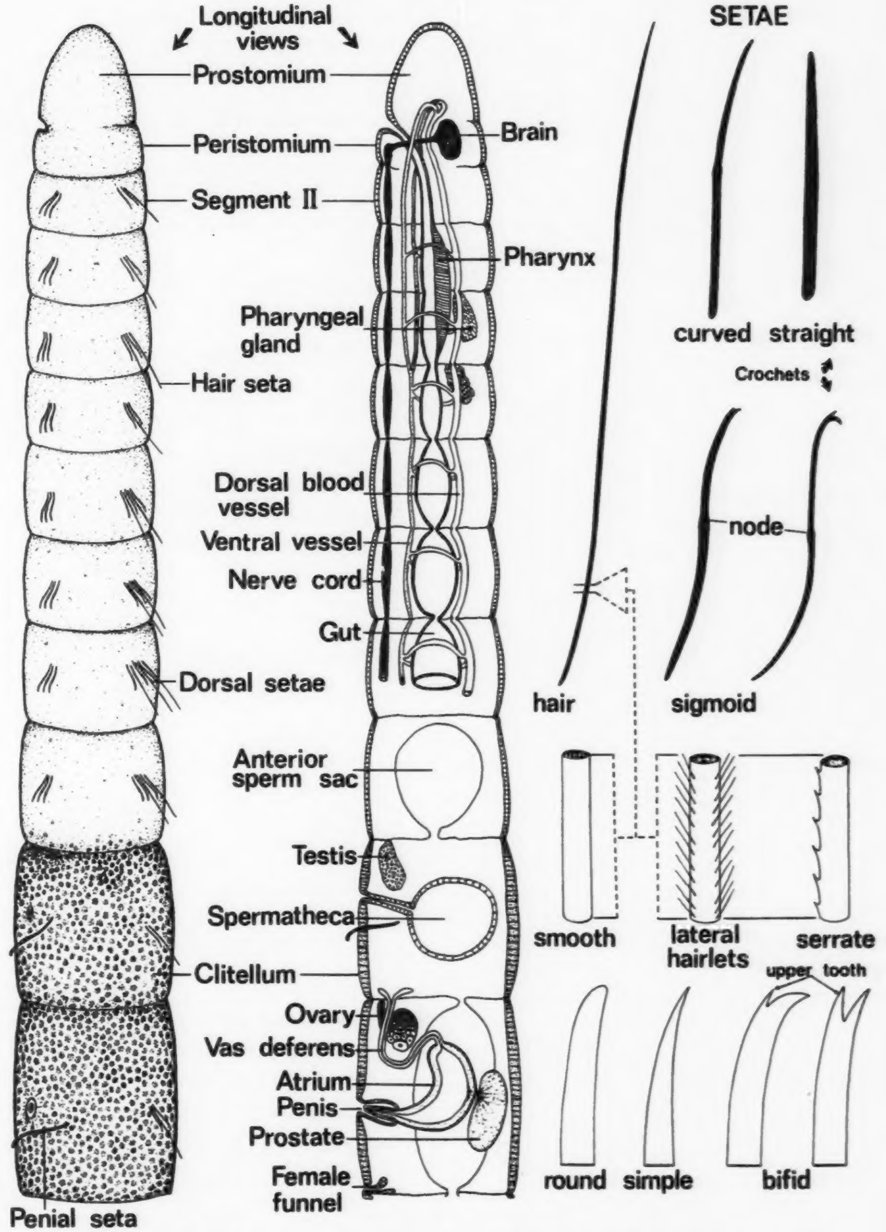


Figure 2.—Left, exterior of anterior portion of an oligochaete; middle, interior view; right, basic types of setae.

Figure 12.—An oligochaete annelid, Figure 2, p. 3, from Cook and Brinkhurst (1973).

Figure 13.—Photograph of Marie B. Abbott, 1977.

a local Cape Cod printer, and with distribution through the MBL Supply Department. This idea was soon abandoned because of the limited distributional facilities of that Department. There followed discussions with a representative of the Harvard University Press in Boston. The options with this Press seemed promising. However, during later negotiations, Wigley suggested yet another approach, publication by the NMFS, which was warmly received by our MFF Editorial Board. This approach coincided with establishment by the NMFS of its Scientific Publications

Figure 14.—Photograph of Arthur G. Humes, 1973.

Staff (now Office) in Seattle, Washington, along with the appointment of a new Scientific Editor, Reuben Lasker, for the NMFS publications *Fishery Bulletin*, a quarterly journal, and the Circular and the Technical Report series.

In May 1972, Wigley submitted his suggestion to the Publication Policy Board of NMFS. This Board met, and to our delight, unanimously agreed to undertake publication and distribution of the series. Lasker, the new NMFS Scientific Editor, had met with the Publication Policy Board, and on April 18, 1972, wrote to Wigley:

"The Publication Policy Board of NMFS met in St. Petersburg, Florida last week and discussed the publication of the Marine Flora and Invertebrate Fauna of New England. The unanimous opinion of the Board was that this is a project that NMFS should undertake. We agreed that our Circular series is the most useful vehicle for the MFIFNE because of the wide circulation it gets. . . . These Circulars will be available from the Superintendent of Documents at a cost of about a cent a page . . .".

At Lasker's suggestion, he and Thomas A. Manar, Chief, NMFS Scientific Publication Staff in Seattle, Washington, met with Abbott, Turner, Wigley, and me in my MBL office on 31 August to "get acquainted" and discuss details of format and publication of the individual "Marine Flora and Fauna" manuals. Lasker's enthusiasm for publishing the series was more than matched by ours in finding an excellent publication outlet, with wide circulation to major libraries not only in the United States but worldwide, and at a reasonable cost for reprints for authors and individual purchasers.

Thus I began transmitting manuscripts to the NMFS Scientific Editor, then Lasker. He, as is still the practice today, had them further peer reviewed before acceptance for publication. Serious planning of the "Marine Flora and Fauna" had begun in 1967, and the Cook and Brinkhurst manuscript, the first sent to Lasker 5 years later in 1972, appeared in print in May 1973.

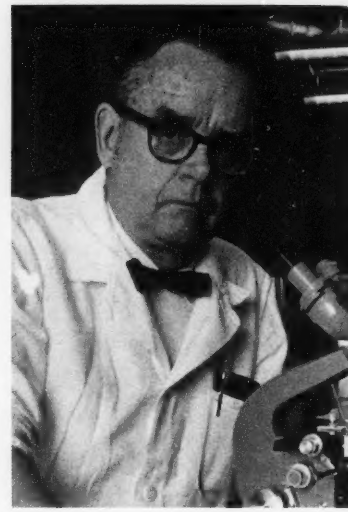


Figure 15.—Photograph of Wesley N. Tiffney, 1970.

Originally, the manuals were published in the NMFS "Circular" series, beginning with the Cook and Brinkhurst's (1973) "Annelida: Oligochaeta," issued officially as NOAA Technical Report NMFS CIRC 374 (Fig. 2). This MFF subseries appeared under that designation until 1984 when the "Circular" series was merged into the overall NOAA Technical Report NMFS series.

Figure 16.—Photograph of Roland L. Wigley, 1981.

The first manual in this series was by Serafy and Fell (1985) on Echinodermata: Echinoidea, issued as NOAA Technical Report NMFS 33 (Fig. 3).

By 1972, funding from agencies and foundations for SEP had become most difficult to obtain. On 31 August of that year, James Ebert, Director of MBL, and I discussed the seriousness of the situation and jointly concluded with goodwill that all things considered it would be prudent to close the Program. Ebert then invited me to remain at MBL for an additional year to advance my research on predatory shell-boring marine gastropods, help my staff find other positions, continue coordination and editing of the "Marine Flora and Fauna," and seek new employment myself. This I did. On 1 September 1973, a year after the closing of SEP, at the invitation of Dean William Gaither and several of my University of Delaware colleagues, I joined the faculty of the College of Marine Studies, University of Delaware, Lewes, Delaware.

Early that September, my wife and I (our sons had by now left home) arrived in Lewes with a large van of scientific supplies and equipment from my MBL research activities, and the complete and carefully guarded files of the "Marine Flora and Fauna"; I was prepared to continue serving as Coordinating Editor. My first task was to promote the series widely through short articles in several scientific journals (Carriker 1973a,b; 1976a).

During this period it was increasingly difficult for individual investigators to obtain financial support for systematic research. I was also keenly aware that systematists collaborating in the preparation of manuals required some financial assistance. Accordingly, I submitted a proposal in 1975 through the University of Delaware on behalf of the MFF Editorial Board to the Environmental Protection Agency in Narragansett, Rhode Island. We received a grant of $18,000. In 1987, I presented a second proposal, this time to the National Science Foundation. For this, we received an award of $12,988. Both grants provided funds for systematists whose manuscripts were well along and who needed funds for illustrations, duplicating manuscripts, and the like.

In more recent years (late 1980's and early 1990's) the squeeze on funding has seriously slowed the preparation of manuscripts, and consequently their transmittal to the NMFS Scientific Editor and the Scientific Publication Office in Seattle, Washington. Despite these straitened circumstances, a few systematists have been able to continue to work, albeit at a snail's pace, on the taxonomy of their favorite organisms. Thus, from time to time an occasional manuscript has reached my office in Lewes, Delaware.

In 1984, Tiffney died and Wigley retired from the Editorial Board of the "Marine Flora and Fauna." They were replaced by A. Ralph Cavaliere, Department of Biology, Gettysburg College, (Fig. 17), and David L. Pawson, curator of Echinoderms, Department of Invertebrate Zoology, Smithsonian Institution (Fig. 18). In 1987, Abbott died, and was succeeded by Kenneth P. Sebens, currently in the Department of Zoology, University of Maryland (Fig. 19), who also serves as Associate Coordinating Editor on the Editorial Board.

Editing and publishing of MFF manuals has been performed in close cooperation with the NMFS Scientific Editors (who serve for 3-year terms) and with the editorial staff of the NMFS Scientific Publications Office in Seattle, Washington. Without exception, communications concerning external review of manuscripts, interaction with authors, and final publication of manuals have been accomplished pleasurably and as expeditiously as NMFS funds and the workload on the NMFS editorial staff permitted. Publication of the more recent manuals has been delayed many months—but through no fault of the

Figure 18.—Photograph of David L. Pawson, 1994.

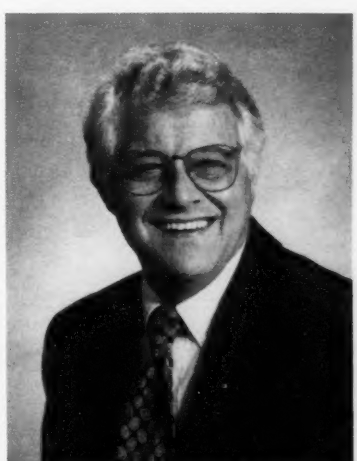


Figure 17.—Photograph of A. Ralph Cavaliere, 1996.

Figure 19.—Photograph of Kenneth P. Sebens, 1994.

NMFS staff—because of the current funding stringencies in the U.S. Government.

Since the inception of the "Marine Flora and Fauna," I have enjoyed my interaction with the editors of the NMFS scientific publications—nine editors in all. This number is rather large because the position of NMFS Scientific Editor has changed every 3 years, rotating from one NMFS Research Center to another. After each triannual change, I have written a lengthy letter with several enclosures to acquaint each new Scientific Editor with the background and organization of the MFF series. The following is a list of these Scientific Editors:

- Reuben Lasker, 1971–74, NMFS Southwest Fisheries Center, La Jolla, Calif.
- Bruce Collette, 1974–77, NMFS National Systematics Laboratory, U.S. National Museum, Smithsonian Institution, Wash., D.C.
- Jay C. Quast, 1977–80, NMFS Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska.
- Carl J. Sindermann, 1980–83, NMFS Northeast Fisheries Center, Sandy Hook Laboratory, Highlands, N.J.
- William J. Richards, 1983–86, NMFS Southeast Fisheries Center, Miami, Fla.
- Andrew E. Dizon, 1986–89, NMFS Southwest Fisheries Center, La Jolla, Calif.
- Linda Jones, 1989–92, NMFS National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, Wash.
- Ronald W. Hardy, 1992–95, NMFS Northwest Fisheries Science Center, Seattle, Wash.
- John B. Pearce, 1995–98, NMFS Northeast Fisheries Science Center, Woods Hole, Mass.

Occasionally, congratulatory letters have been received from the Scientific Editors. On October 17, 1984, for example, William J. Richards wrote:

"I certainly find this series on the Marine Flora and Fauna of the Northeastern United States to be of outstanding quality and wish that workers in the other three corners of the country would consider doing the same thing."

And on March 3, 1987, Andrew E. Dizon wrote:

"As in the past, NMFS will be pleased to consider for publication manuals in your excellent series 'Marine Flora and Fauna of the Eastern United States' (MFFEUS). Because of the thorough review process through which you put your manuscripts before submission, I anticipate no problems in the acceptance and eventual publishing of the ten manuals listed in your NSF proposal. As Scientific Editor of the 'Fishery Bulletin' and of the 'Technical Reports', I feel that the MFFEUS series is an important scientific contribution and am pleased to contribute to its production."

Since 1972, four different people have served as Chief of the NMFS Scientific Publications Office in Seattle, Wash., and have interacted importantly and cordially with us during processing of manuscripts. In chronological order, these have been: Thomas A. Manar, Joseph D. Harrell, Jack McCormick, and Willis L. Hobart. Equally pleasant have been our relations with the Managing Editors of the NMFS Circulars and Technical Reports in the same office. Again, in chronological order these are: Mary Fukuyama, Lee Thorson, Nancy Peacock, Sharyn Matriotti, and James Orr (currently the Managing Editor position for the NMFS Technical Reports remains unfilled).

Congratulatory comments on the "Marine Flora and Fauna" series and their illustrations have also been received from teachers and researchers who have found the manuals important in their work. Figures 20–28 are examples of representative illustrations in the manuals selected at random in the order of year of publication (Table 1).

J. Frances Allen, Staff Scientist, U.S. Environmental Protection Agency, 1973:

"I am pleased to have your recent letter on the 'Flora and Fauna' and the two manuals on the Ciliophora and on the higher plants of the marine fringe. It is indeed gratifying to see them and to look forward to others as they become available. I am sure you are hearing many fine things about the 'Flora and Fauna'".

Kenneth J. Boss, Museum of Comparative Zoology, Harvard University, 1973:

"We all await the new revised series, one of which arrived this week. Cook and Brinkhurst's [1973] contribution appears to have initiated a high quality group of helpful aides to the study of the marine organisms of the Northeastern United States. Congratulations and thanks again."

Emery F. Swann, Department of Zoology, University of New Hampshire, 1973:

"I have received Cook and Brinkhurst's [1973] report on the Oligochaeta. This is certainly a nice piece of work, and if succeeding manuals of the series are up to its standard, the series will be very valuable indeed."

Lorus J. Milne, Department of Zoology, University of New Hampshire, 1975:

"It has come to my attention that in the series of manuals entitled 'Marine Flora and Fauna of the Northeastern United States', those by Raymond B. Manning on the stomatopod crustaceans and by Austin B. Williams on the decapod crustaceans are presently unavailable, and others are in short supply. I do hope that you will use all the pressure you can exert from your office to have the two out-of-print manuals reprinted and to keep all of them in stock with the Superintendent of Documents. These manuals on identification of marine life are of immense value to students and to the growing number of ecological consultants who must sample coastal organisms toward presentation of environmental-impact statements".

Winifred Dickinson, Beaver Campus, Pennsylvania State University, 1977:

"Thank you for the manuals in the 'Marine Flora and Fauna of the Northeastern United States' series, the Holothuroidea [Pawson, 1977] and higher plants of the marine fringe [Moul, 1973]. We used two of the manuals last year and found them to be most workable".

Joseph E. McCarthy, Biddeford High School, Maine, 1977:

"I am an instructor in Marine Science and Marine Biology at the high school level.... Most of the keys for our area are too spotty or overly technical for most of our students. I have seen a single publication from the series you are coordinating relating to the Stomatopoda by Manning [1974]. If the other articles are as well illustrated and written, they will be of great service to students of marine biology".

Mary Hanson Pritchard, Zoology and Museum, University of Nebraska, Lincoln, 1977:

"The manuals are excellent and I commend you and your authors for an important, much needed undertaking. It is most understandable that it is a labor of love—I'm just delighted that the work can be published under the aegis of NOAA. Looking over the list of specialists, I know you will have an impressive set of manuals when the project is completed."

David L. Pawson, Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, 1979:

"Many thanks indeed for sending me copies of the three manuals, all of which appear to be excellent additions to your distinguished series. The response by institutions and individuals, even to the manual on such an unpopular group as the holothurians [Pawson, 1977] has been amazing, and testifies to the value of your project. You can be justly proud that your yeoman efforts have resulted in a series which is exceedingly useful".

Arthur Bedard, Science Coordinator, Canton Public Schools, Massachusetts, ca. 1980:

"I wonder if you would have a minute to send me an updated list of the Marine Flora & Fauna... publications. They have been of great value and I fear that I am starting to miss some of the reports".

Douglas J. Barr, National Museum of Natural History, Smithsonian Institution, ca. 1980:

"I am an instructor for a marine biology course offered by the University of Southern Maine (USM). The course is based almost entirely on field research carried out along the coast of Maine, therefore I rely heavily on MFFNEUS manuals."

John B. Pearce, NMFS Northeast Fisheries Science Center, Woods Hole, Massachusetts, 1996:

"From my point of view, much of the ecology and taxonomic research in recent decades in the waters off of New England and the Mid-Atlantic Bight have been accomplished using the Smith [1964] manual, the several MFF manuals [Table 1], and the volume by Bousfield [1973]. Ann Frame, and others working with the perocarids and other arthropods, turn regularly to the Bousfield document, and the other publications are used in a range of courses and researches ongoing in the Woods Hole area. I continue to use the Smith [1964] manual and the other publications in my research on epi-benthic communities and pollution effects".

In 1987 the name of the MFF series was changed to the "Marine Flora and Fauna of the Eastern United States" better to reflect the geographic coverage of many of the manuals. By now, the fall of 1996, 28 manuals have been published in the series; some of these have been superbly illustrated (Fig. 20–28). Three more manuals are in press: Kenneth P. Sebens on the Anthozoa, Sherman S. Hendrix on the monogenean Platyhelminthes, and Omar M. Amin on the Acanthocephala (Table 1). Several more manuscripts are in various stages of preparation.

Contributing to the early and continuing success of the "Marine Flora and Fauna" have been the high quality of the systematic effort put forth by highly supportive collaborating systematists, the early stimulus extended by the pivotal support of the SEP staff, the extensive MBL Library, and the stimulating milieu of the Woods Hole scientific community.

Success of the MFF series has been achieved, especially recently, under penurius circumstances. Research and writing on many of the manuscripts has been done with no or little financial support, carried out "on the side" or as a "labor of love" that is enjoyed, found satisfying, and productive. Although this frugal approach is admirable in a fiscal sense, realistically it sidesteps the greater issue of the niggardly sums generally available for universally needed classification and identification literature (Schmitt, 1967; Mayr, 1969; Michener et al., 1970; Raven, 1990, Simpson and Cracraft, 1995), and overlooks the fundamental importance of taxonomy and systematics as the "primordial biological fabric" (Carriker, 1991).

One might then finally ask, "What specifically is the universal need and importance of a biosystematic series like the "Marine Flora and Fauna?" The answer lies in the certainty that all hierarchical levels (genetic, species, and ecologic) of the biodiversity of the world ocean (Thorne-Miller and Catena, 1991; Norse, 1993) are being increasingly assaulted by a human anthropogenic blitzkrieg. And the only way to monitor the creeping rate of biotic deterioration is by biological inventories of representative areas (Norse, 1993; Systematics Agenda 2000, 1994; Butman and Carlton, 1995; Collette and Vecchione, 1995; Vecchione and Collette, 1996). But biological inventories of all kinds inescapably depend on identification instruments—among them, for example, the MFF—for accurate identification and classification. Some far thinking persons (Norse, 1993) go so far as to recommend that industrialized nations establish national institutes for the environment, which among other functions, should coordinate and fund national marine biodiversity inventories to provide informa-

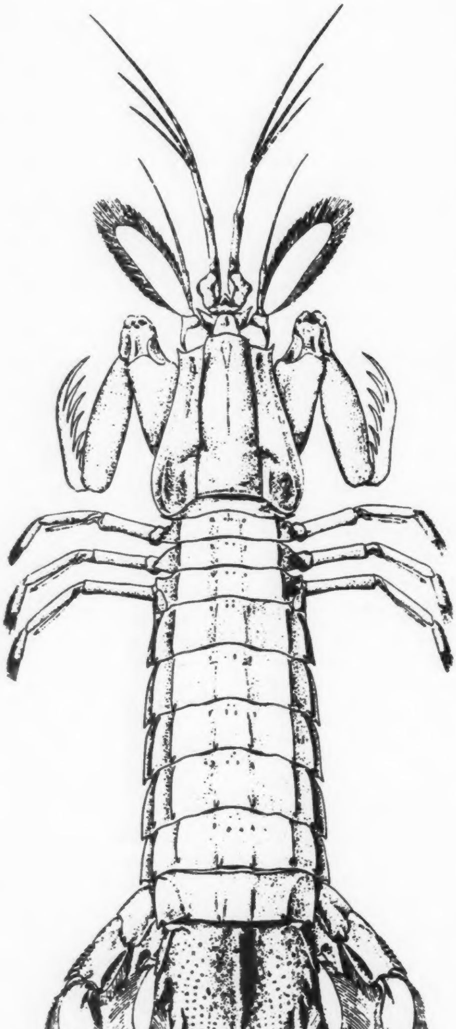


Figure 8.—*Squilla empusa*. Dorsal view (from Manning, 1969).

Figure 20.—A stomatopod crustacean, Figure 8, p. 4, from Manning (1974).

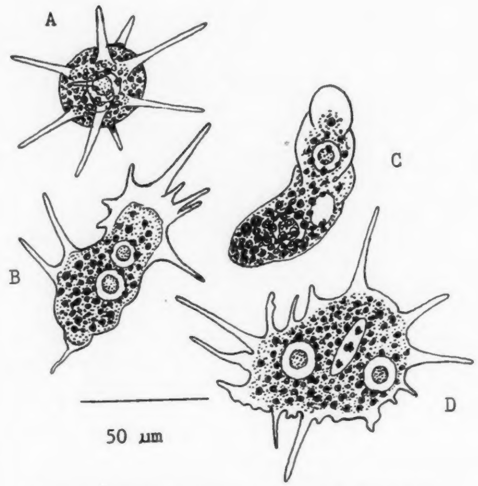


Figure 34.—*Striolatus tardus*: A—radiate, afloat; B—beginning locomotion; C—feeding, active stage; D—slowly locomotive; after Schaeffer (1926).

Figure 21.—Different stages of a sarcodinian amoeba, Figure 34, p. 25, from Bovee and Sawyer (1979).

27(25) Three filamentary appendages; upper part of peduncle orange in live specimens .... *Lepas hilli*

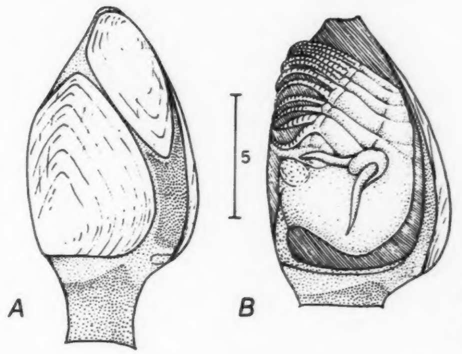


Figure 38.—*Lepas hilli*: A. lateral view of capitulum; B. cutaway of capitulum showing body with three filamentary appendages at base of first thoracic limb. Scale in millimeters.

Figure 22.—A goose barnacle, Figure 38, p. 23, from Zullo (1979), illustrated by Ruth von Arx.

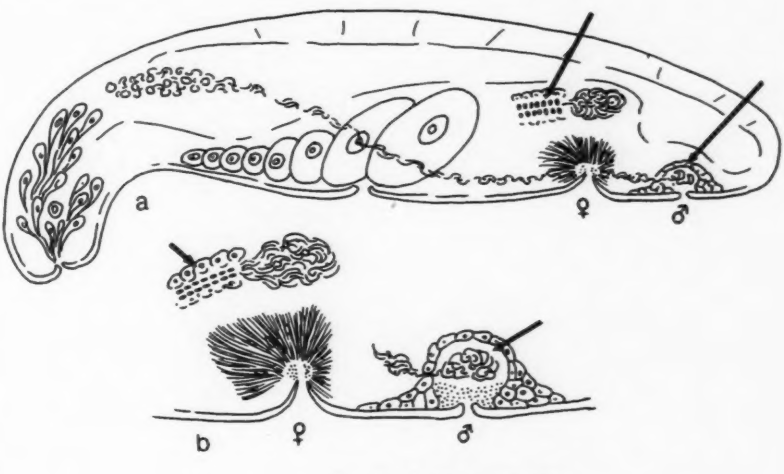


Figure 72.—*Pseudohaplogonaria vacua*.

Figure 23.—A turbellarian flatworm, Figure 72, p. 26, from Bush (1981).

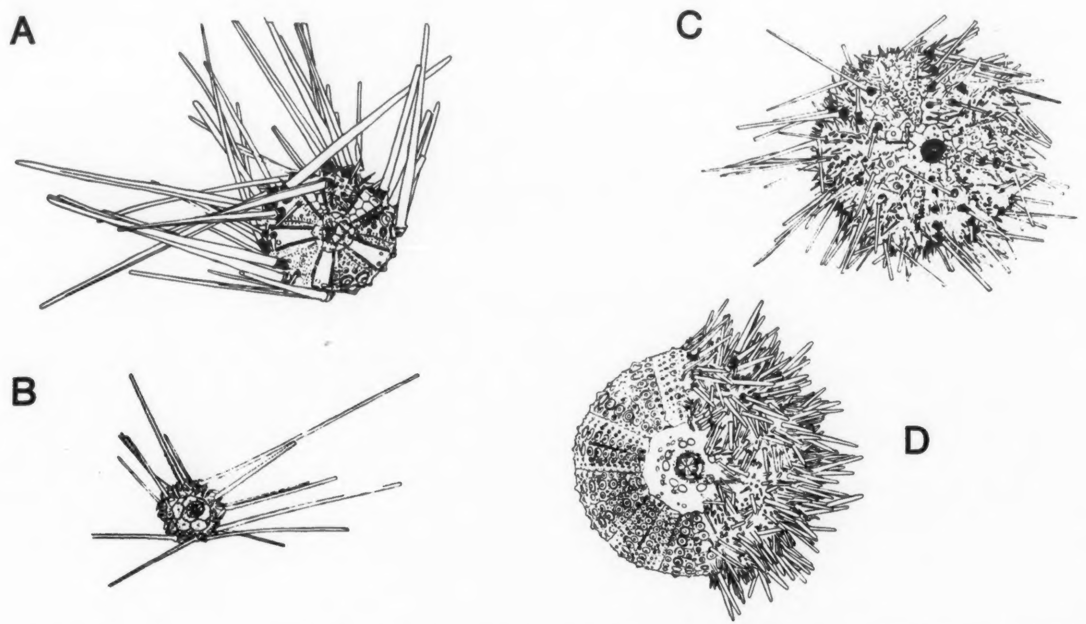


Figure 5.—Examples of regular urchins. A, *Coelopleurus* (aboral aspect); B, *Salenocidaris* (aboral aspect); C, *Echinus* (aboral aspect); D, *Strongylocentrotus* (oral aspect).

Figure 24.—Echinoid echinoderms, examples of sea urchins, Figure 5, p. 6, from Serafy and Fell (1985).

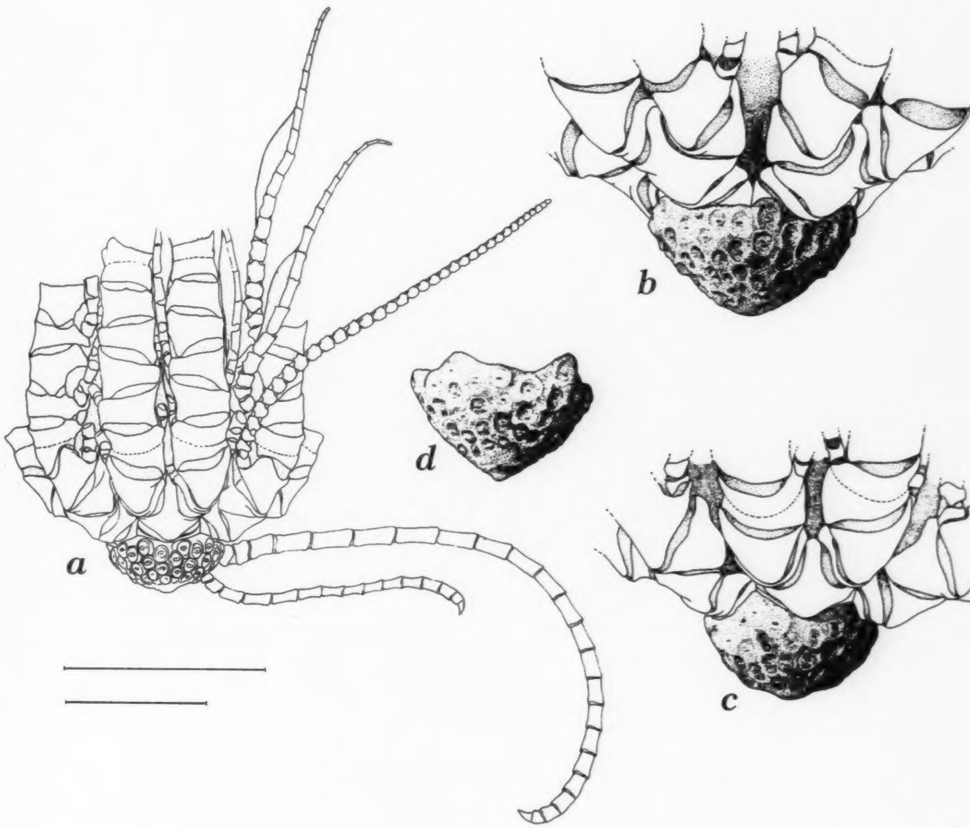


Figure 14

Coccometra hagenii. (*a*) Lateral view showing centrodorsal, small apical and large peripheral cirrus, and bases of three rays showing P_1, P_2, and P_3 (P_2 and P_3 bear gonads); (*b* and *c*) Lateral views showing centrodorsal and bases of rays; (*d*) Centrodorsal. Scales: upper, *a* = 5 mm; lower, *b–d* = 2 mm.

Figure 25.—A crinoid echinoderm, a feather star, Figure 14, p. 18, from Messing and Dearborn (1990).

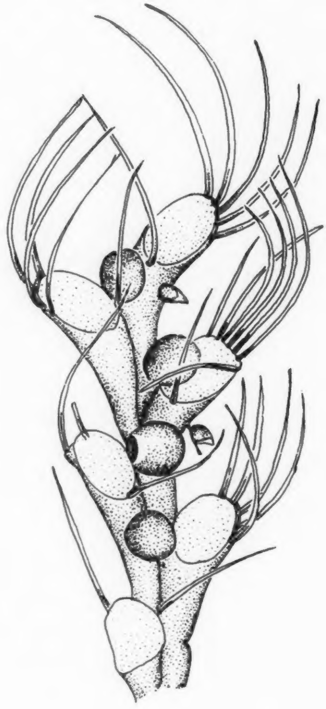


Figure 45
Bicellariella ciliata. Scale: 0.5 mm.

Figure 26.—An erect bryozoan, a moss animal, Figure 45, p. 32, from Ryland and Hayward (1991).

tion to decision makers in health and medical research, biotechnology, agriculture and fisheries, industries, government, conservation and resources, ecotourism, and basic biological sciences. In addition to classical taxonomy, new state-of-the-art techniques, such as the use of DNA analyses, are now available to establish the taxonomic basis for many groups of marine mammals, fishes, and invertebrates, especially of groups of species once thought to be one species (J. B. Pearce, NMFS, NEFSC, personal commun.).

From my perspective it is certain that classical procedures in taxonomy and biosystematics will continue to be the indispensable master keys that swing open the doors to an understanding of the community structure and function (Butman and Carlton, 1995) of our vitiating world-ocean ecosystem. No substitutes appear over the horizon.

Undeniably, the systematic task that we in SEP set before ourselves as we launched the "Marine Flora and Fauna" is far from complete; the substantial voids in the list of taxa of algae and invertebrate animals yet to be addressed are painfully evident in Table 1. But true as this is, beside the significant list of widely circulated useful manuals already in print, a successful prototype has effectively demonstrated that the "Marine Flora and Fauna" can serve as a model in the organization and operation of future flora and fauna programs in representative regions of the world.

Acknowledgments

I am pleased to thank the current members of the MFF Editorial Board

3(2) Ink sac present; arms moderately long; suckers large; cirri above eyes small or absent; ligula of hectocotylized right arm III of males very small .... ***Octopus vulgaris* (Fig. 15)**

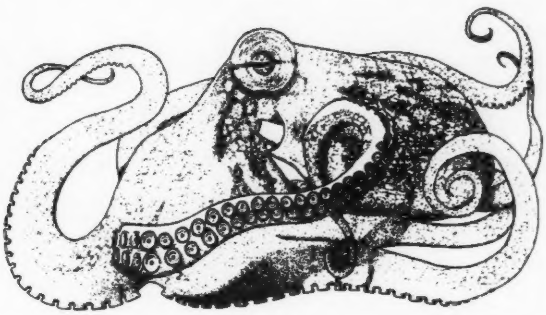


Figure 15
***Octopus vulgaris* (lateral aspect).**

Figure 27.—An octopus, Figure 15, p. 7, from Vecchione et al. (1989).

for their comments and suggestions on the manuscript: A. Ralph Cavaliere, Arthur G. Humes, David L. Pawson, Kenneth P. Sebens, Ruth D. Turner, and Robert T. Wilce; as well as John B. Pearce, Willis L. Hobart, and Donald J. Zinn for their helpful suggestions. Thanks go also to Kate Tuttle for a copy of the photograph of Ruth D. Turner, to Judith E. Winston for the photograph of Marie Abbott, and Boston University Photo Services for the photograph of Wesley N. Tiffney. I am grateful to Linda Leidy for preparing the final typescript. And finally, I want to thank Willis L. Hobart for originally offering me the opportunity to prepare this history of a systematics odyssey.

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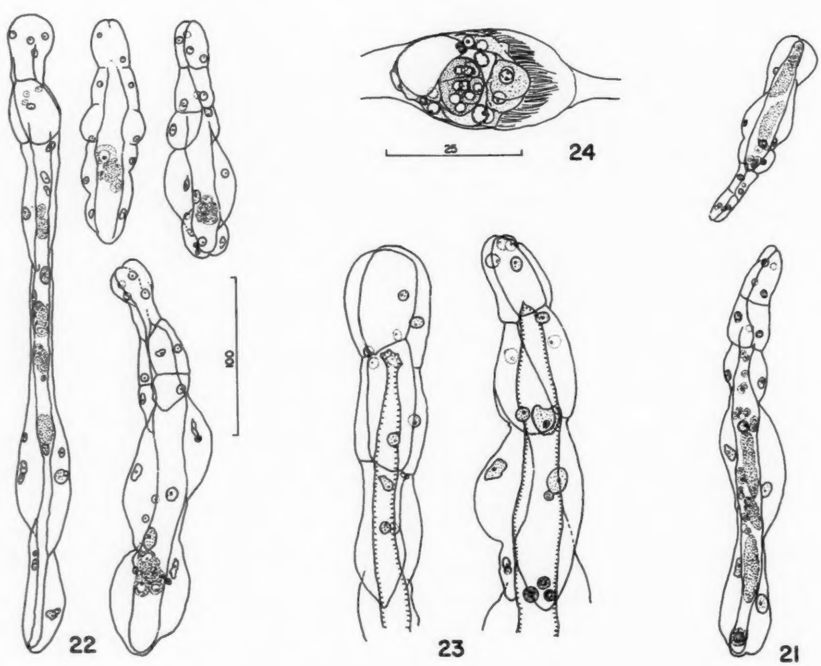
4(3) Lengths of mature nematogens 254 to 264 μm, mature rhombogens 438 to 657 μm. Somatic cell number almost invariably 14. Calotte markedly elongate; in young vermiform individuals often 30 to 50% of total length, in largest vermiforms 14 to 20% of total length. Parapolar cells usually shorter than calotte. Vermiform embryos about 40 to 50 μm long at eclosion. Refringent bodies, in infusoriforms viewed laterally, appearing larger than cluster of urn cells (*see* Fig. 3B) .... ***D. hypercephalum* (Figs. 21–24)**

Host: *Octopus joubini* Robson, 1929



Figures 21–24

Dicyema hypercephalum. **(21)** Nematogens. **(22)** Rhombogens. **(23)** Anterior ends of rhombogens. **(24)** Infusoriform within axial cell of rhombogen, sagittal optical section. All figures from Short (1962). Scales in micrometers. Cilia not shown on vermiform stages.

Figure 28.—A dicyemid mesozoan, Figures 21–24, p. 9, from Short (1991).

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Recent Trends in the Catch of Undersized Swordfish by the U.S. Pelagic Longline Fishery

JEAN CRAMER

Jean Cramer is with the Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149.

ABSTRACT—U.S. commercial vessels fishing in the Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico have been subject to regulations limiting the landing of swordfish less than 25 kg whole weight since June 1991. The intent of those regulations was to reduce the mortality of immature swordfish. Plots of fishing effort from 1990 to 1994 indicate that the regulations were effective in some areas. Fishing effort decreased after 1991 in the Venezuelan Basin, a swordfish nursery area. However, in areas close to the U.S. coastline, effort did not appear to shift away from areas where immature swordfish were caught. In these areas, many swordfish were discarded . To identify areas with high rates of discarding, plots were made showing areas where the number of discarded swordfish was equal to or greater than the number of fish landed.

Introduction

In 1990 the Standing Committee on Research and Statistics (SCRS), the scientific body of the International Commission for the Conservation of Atlantic Tuna (ICCAT), determined that the recent (1988–89) levels of swordfish mortality in the north Atlantic, north of 5° north latitude (Fig. 1), could not be maintained without a significant probability of detrimental effects on future swordfish yields (Anonymous, 1995). In response to these findings, ICCAT recommended a 15% decrease in the mortality of swordfish in the North Atlantic compared to 1988 levels (Anonymous, 1995). Furthermore, SCRS analyses indicated that the greatest opportunity for increasing long-term yields was to increase the effective minimum size (Anonymous, 1995). All ICCAT contracting parties were asked to take measures to reduce landings of swordfish weighing less than 25 kg whole weight (125 cm lower jaw fork length (LJFL)) to an incidental catch of not greater than 15%, by number, of the total swordfish caught (Anonymous, 1995).

In compliance with ICCAT recommendations, in June 1991, the United States established a total allowable catch (TAC) for swordfish of 4,163 metric tons (t) whole weight and a minimum size limit of 25 kg whole weight with a 15% allowance for undersized swordfish based on the number of swordfish landed per fishing trip. A final ruling in August 1992 set the U.S. TAC at 4,560 t (Matlock, 1995).

Although swordfish landings by U.S. and Spanish fishermen decreased each year from 1991 to 1993, swordfish landings of some other nations increased. The 1994 SCRS analyses for North Atlantic swordfish indicated that mortality had not declined below 1988 levels and may have substantially increased. In addition, the effectiveness of the minimum size regulation was limited since relatively high numbers of swordfish were discarded dead. The only marked declines in landings of swordfish less than 125 cm LJFL in the Atlantic Ocean were in the U.S. pelagic longline fishery landings. The majority of swordfish discarded dead, assumed to consist primarily of undersized fish, were also attributable to the U.S. pelagic longline fishery (Anonymous, 1995).

Based on these findings, ICCAT, recommended further reductions in swordfish landings in the North Atlantic and

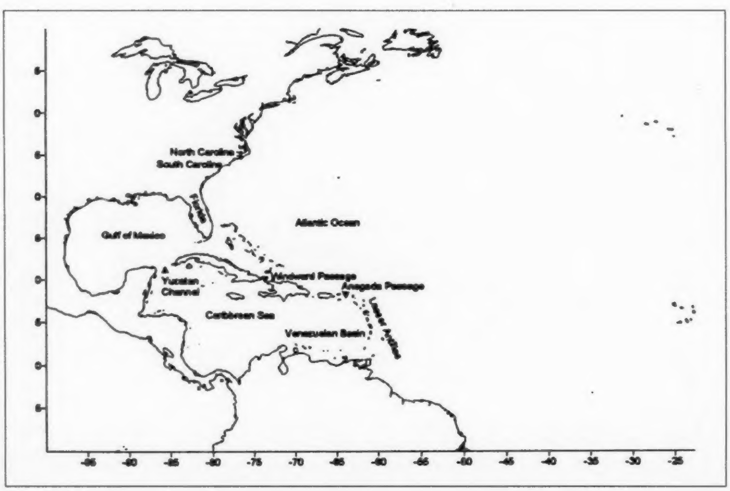

Figure 1.—Locations referred to in the text.

encouraged contracting parties to retain minimum swordfish size regulations and to take other appropriate measures to protect small swordfish including, but not limited to, the establishment of time and area closures.[1] This paper examines changes in U.S. swordfish longline landings and effort since 1990, identifies areas with high swordfish discard rates, and estimates the cost, in terms of landings, of reducing the catch of undersized swordfish by this fishery.

Materials and Methods

U.S. commercial vessels that land swordfish in the Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico are required to submit daily records of effort and catch, including the number of hooks set, the location in latitude and longitude at the beginning of the set, and the numbers and species of fish kept, discarded dead, and discarded alive. In addition, records of fish sold, including dressed weights and species of fish, must be submitted after each fishing trip.

Reported dressed weights were used to calculate the percentage (by number) of swordfish caught in 12 kg size categories and cumulative monthly weights for years 1990 through 1994. Whole weights were estimated from the reported dressed weights by multiplying by a conversion factor of 1.33 (Miyake, 1990).

To look at changes in effort between years, records were grouped by one-degree (latitude and longitude) squares. Hooks were summed for each of these one-degree areas. Yearly minimum, maximum, and median values for hooks are given in Table 1. Locations of reported effort were plotted on maps for each year from 1990 through 1994. The size of the circles at each one-degree area was set proportionally to the number of hooks set in that area.

Records for each year from 1992 through 1994 were grouped by one-degree area and quarter (A/Q) to identify areas and seasons with high rates of swordfish discarding. In this paper, all discarded swordfish are assumed to be undersized. Quarters are defined in Table 2.

A discard ratio was calculated for each A/Q. The discard ratio is taken as:

$$\textit{Discard Ratio} = (\textit{swod} + \textit{swoa}) \,/\, (\textit{swod} + \textit{swoa} + \textit{land}),$$

where *swod* is the number of swordfish discarded dead, *swoa* is the number of swordfish discarded alive, and *land* is the sum of the numbers of swordfish, tunas, and sharks landed. Fish that are not discarded, and are generally sold, are referred to as landed.

To determine the cost of reducing the catch of undersized swordfish in years 1992 through 1994, in terms of the reduction in the numbers of fish landed, A/Q's were sorted in descending order by the discard ratio. A/Q's were then removed in order starting with the highest discard ratio. The percentage of swordfish removed and the percentage of total landed fish (swordfish + tuna + sharks landed) removed were calculated and plotted.

Results and Discussion

Monthly cumulative landing of swordfish for years 1990 through 1994 are shown in Figure 2. Yearly swordfish landings declined from 1990 to 1994 and have remained below the U.S. TAC of 4,560 t since 1991 (Table 3). At least part of this decline is a result of the 1991 minimum size regulation. In

[1]Management recommendations and related resolutions adopted by ICCAT for the conservation of Atlantic tunas and tuna-like species. Unpubl. Rep. Com-95-26, p. 35. 1995. Estebanez Calderon 3, 28020 Madrid, Spain.

Table 1.—Range of hooks reported for data grouped by one-degree areas within years.

Years	Minimum	Median	Maximum
1990	132	2,400	229,610
1991	180	3,450	206,737
1992	200	2,548	285,384
1993	240	3,100	319,466
1994	150	3,220	388,738

Table 2.—Quarters used in these analyses begin and end on the calender days indicated in this table.

Quarter	Beginning	Ending
1	January 1	March 31
2	April 1	June 30
3	July 1	September 30
4	October 1	December 31

Table 3.—Annual U.S. swordfish landings.

	Whole weights (t)	
Year	Landings	Discards
1990	5,494	NA[1]
1991	4,310	215
1992	3,852	384
1993	3,782	409
1994	3,365	508

[1] NA = not available

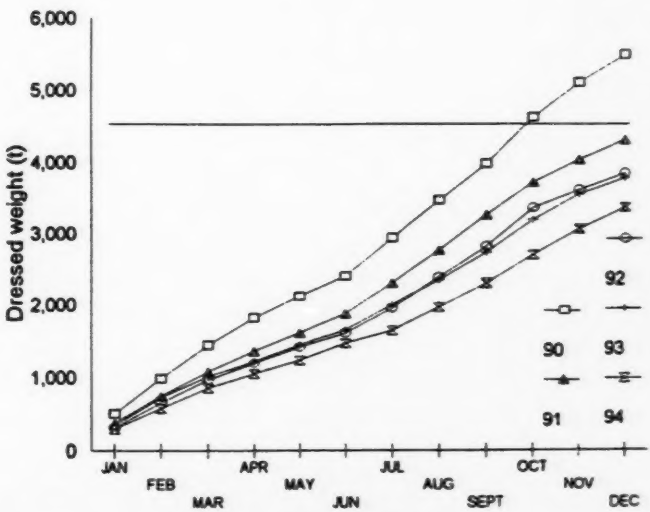

Figure 2.—Cumulative swordfish landings.

1990 the highest percentage (in number) of fish landed was in the predominantly juvenile 13–24 kg size category. In 1991 this peak shifted to the 25–36 kg category where it has remained (Fig. 3). Although the landings of small fish have declined, the minimum size regulation has had limited success in decreasing the estimated mortality of juvenile swordfish because the number of swordfish discarded dead has increased each year since 1991 (Table 3).

In some sectors, the U.S. pelagic longline fleet has altered fishing patterns, presumably to avoid capturing undersized swordfish. Between 1990 and 1994, longline effort shifted away from areas in the southern Caribbean such as the Venezuelan Basin. The Venezuelan Basin is thought to be a nursery area for swordfish since a high proportion of swordfish caught in this area are undersized.[2] At the same time, effort increased in swordfish spawning areas such as the Yucatan Channel, the Windward Passage, the Anegada Passage, and northeast of the Lesser Antilles where mature swordfish are predominant (Arocha and Lee, 1995). Altered fishing patterns were not apparent closer to the U.S. coastline where catches of undersized swordfish tend to be high such as near shore areas off the Florida east and west coasts and off the Carolinas (Fig. 4–9).

[2]Freddy Arocha, Rosenstiel School of Marine and Atmospheric Science, 4600 Rickenbacker Causeway, Miami, FL 33149. Personal commun., 1995.

The graphs in Figure 9 show the relationship between swordfish discards and total landings of swordfish, tuna and sharks in each full year since the minimum size regulation (1992 through 1994). The reductions in the percentage of swordfish discarded were plotted against reductions in the total landings (swordfish, tuna, and sharks landed) as A/Q's were systematically eliminated starting with the highest discard ratios. Reductions in the percentage of swordfish discarded were also plotted against reductions in the percentage of swordfish landed (a subset of the total landings). Reductions in swordfish discards of 50% corresponded to a reduction of approximately 10% of total landings and reductions of approximately 30% of swordfish landings. These figures indicated that undersized swordfish are more likely to be caught on sets targeting swordfish than on sets targeting tuna or sharks, and that they seem to be becoming more concentrated by area and quarter.

A/Q's with discard ratios equal to or above 50% were plotted on maps for each year and quarter from 1992 to 1994 (Fig. 10–12). The size of the indicators on these maps is proportional to the number of swordfish discarded in each A/Q (Table 4). A growing percentage of swordfish discards are being caught in A/Q where 50% or more of the catch of a longline set must be discarded. These A/Q's appear to be concentrated and fairly consistent between years. A/Q's with reported discard rates at or above 50% accounted for only 8% of the swordfish discarded in 1992. In 1993, 27%, and in 1994, 37% of discarded swordfish were caught in sets reporting a discard rate of at least 50% (Table 5). In 1993 and 1994, both the number of A/Q's records having discard ratios at or above 50% and the number of swordfish reported discarded at these A/Q's, increased.

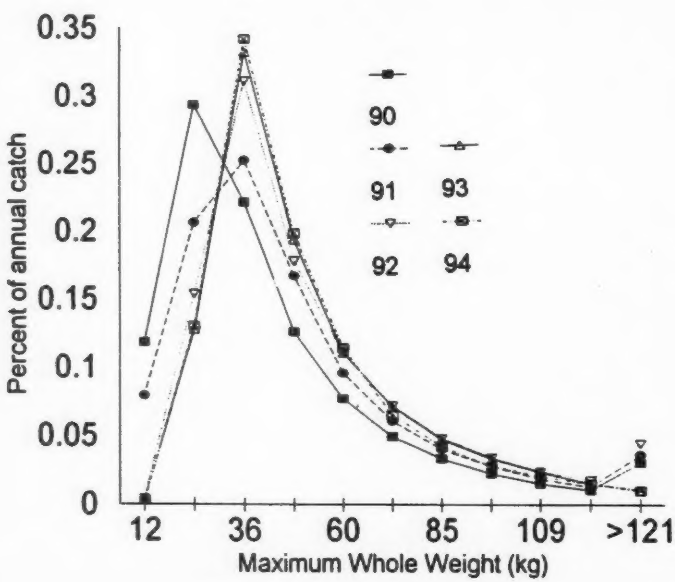

Figure 3.—U.S. swordfish catch at size.

Summary

The 1992 minimum swordfish size regulations have had limited success in deceasing the estimated mortality of juvenile swordfish. Although the times and locations having high rates of swordfish discarding are fairly consistent, a shift in fishing patterns has not been apparent close to the U.S. coastline. High swordfish discard rates have continued and occur primarily when swordfish are targeted.

Table 4.—Range of number of discards reported in one-degree areas and quarters (A/Q) where discard ratios were 50% or higher.

Year	Minimum	Maximum
1992	1	459
1993	2	1,199
1994	1	1,484

Table 5.—Percentage of swordfish discards, total landings (swordfish, tuna, and sharks), and swordfish landings remaining after one-degree area and quarter (A/Q) records with discard ratios equal to or greater than 50% are removed.

Year	Swordfish discards	Total landings	Swordfish landings
1992	8	1	2
1993	27	3	8
1994	37	4	11

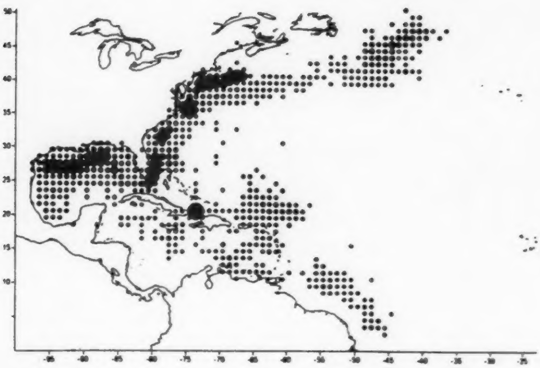

Figure 4.—Location and density of reported commercial fishing effort in 1990.

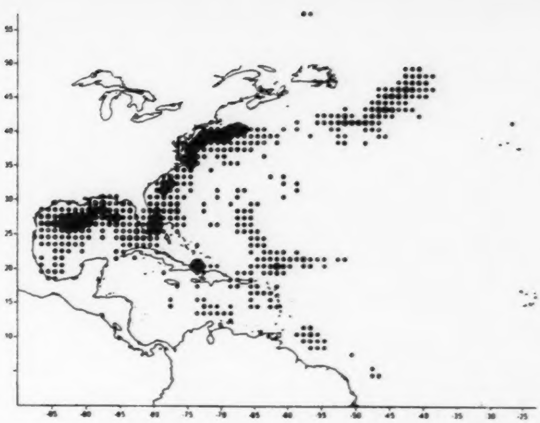

Figure 6.—Location and density of reported commercial fishing effort in 1992.

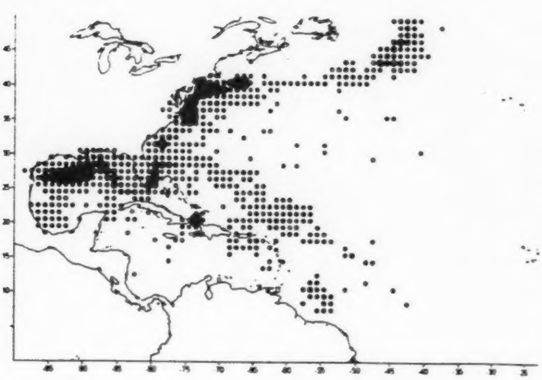

Figure 5.—Location and density of reported commercial fishing effort in 1991.

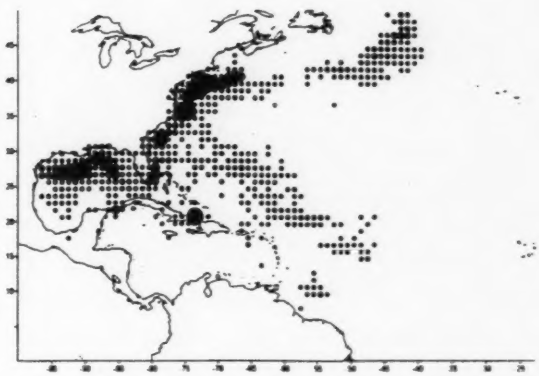

Figure 7.—Location and density of reported commercial fishing effort in 1993.

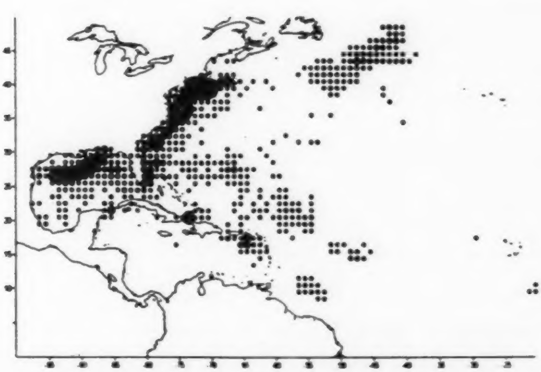

Figure 8.—Location and density of reported commercial fishing effort in 1994.

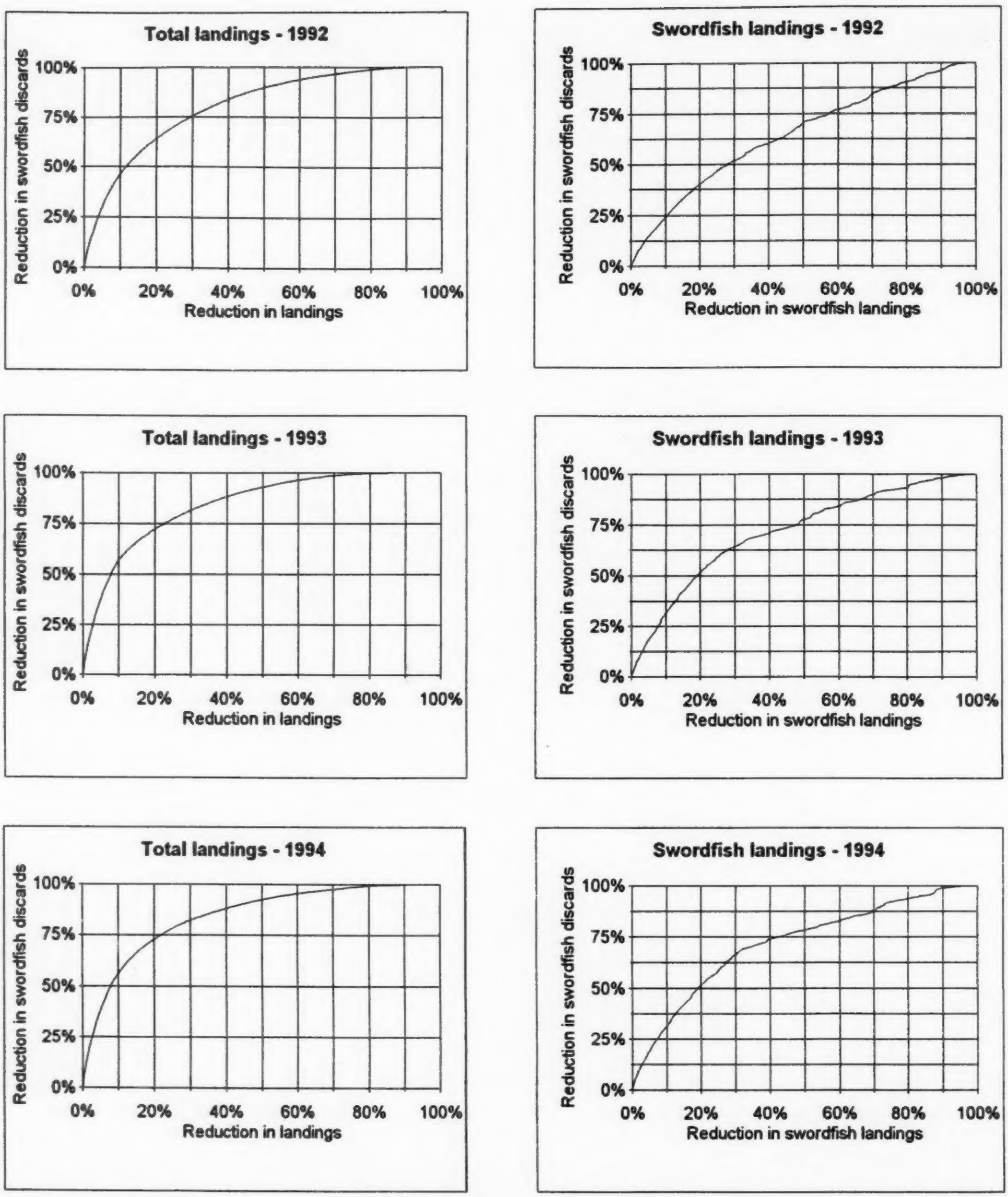

Figure 9.—The cost, in terms of total landings, of reducing swordfish discards.

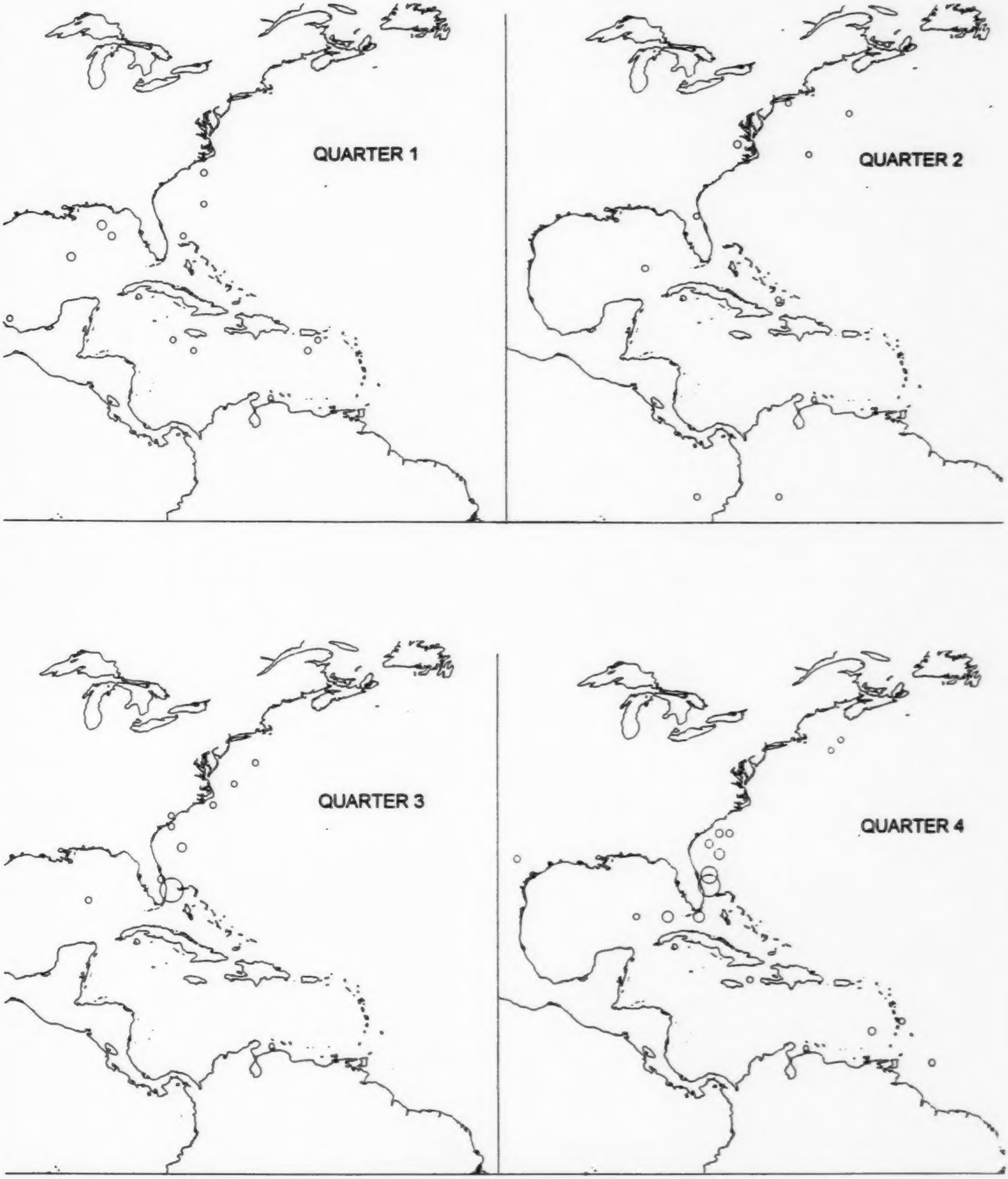

Figure 10.—U.S. longline locations where the number of swordfish discarded was equal to or greater than the number of fish landed in each one-degree square area and quarter of 1992. Circles are proportional to the number of swordfish discarded.

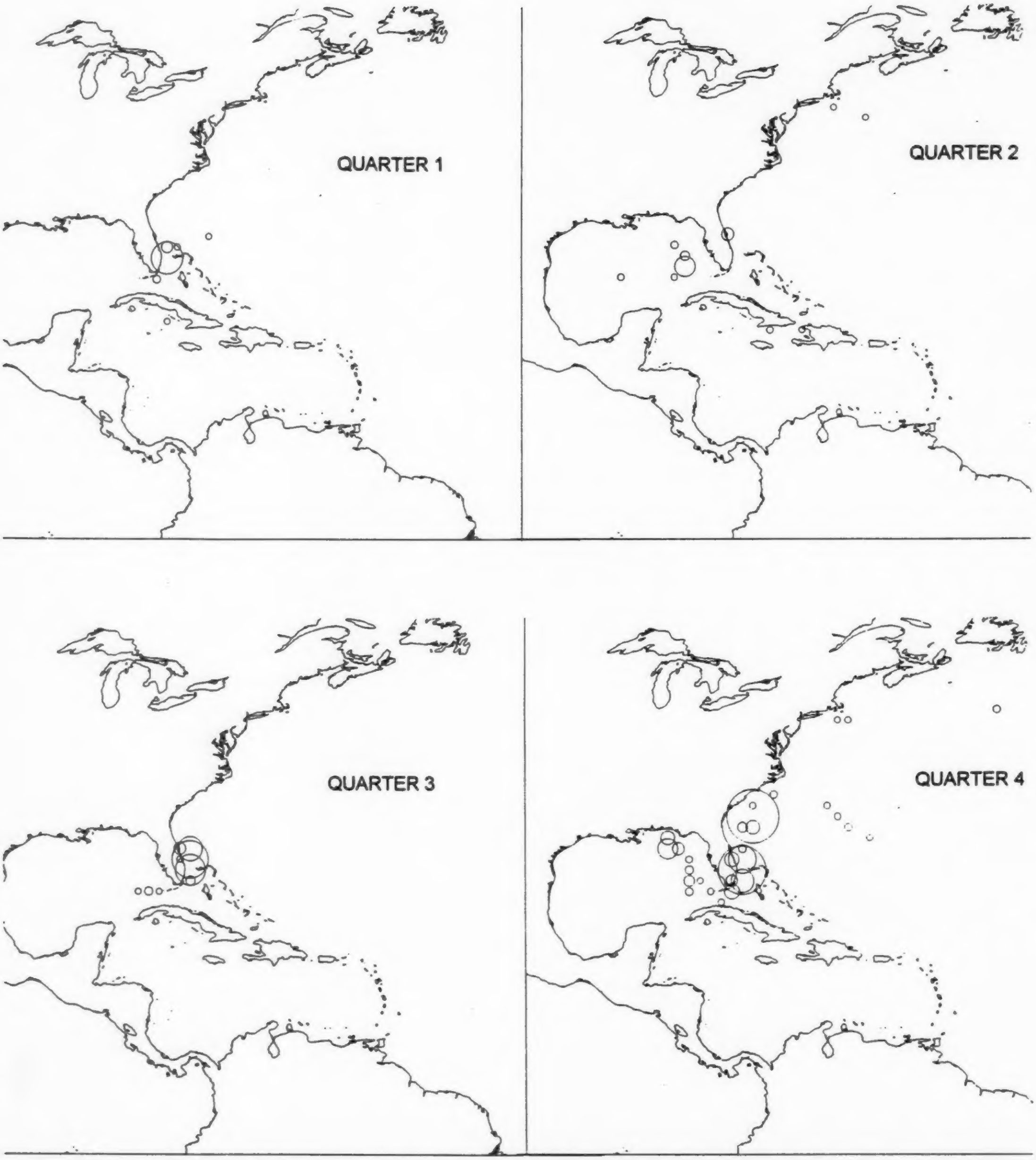

Figure 11.—U.S. longline locations where the number of swordfish discarded was equal to or greater than the number of fish landed in each one-degree square area and quarter of 1993. Circles are proportional to the number of swordfish discarded.

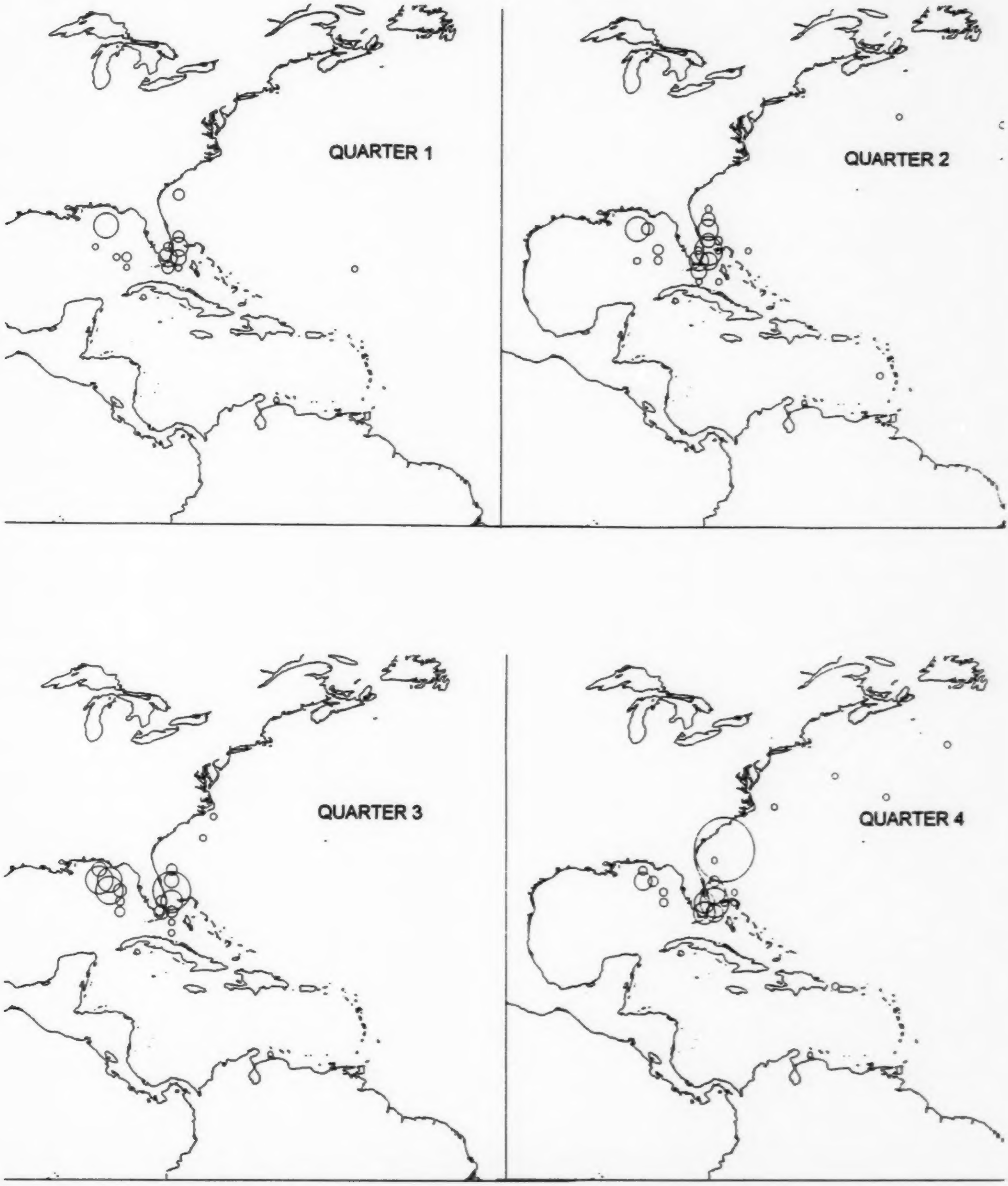

Figure 12.—U.S. longline locations where the number of swordfish discarded was equal to or greater than the number of fish landed in each one-degree square area and quarter of 1994. Circles are proportional to the number of swordfish discarded.

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The Crustacean and Molluscan Fisheries of Honduras

CLYDE L. MACKENZIE, Jr., and LINDA L. STEHLIK

Introduction

Honduras, bordered by Nicaragua in the south and Guatemala and El Salvador on the west, has fisheries for crustaceans and mollusks along its 575 km north coast and in the Gulf of Fonseca (70 km across) in the south (Fig. 1). Along the northern coast, artisanal fishermen land Caribbean spiny lobsters, *Panulirus argus*; white shrimp, *Penaeus schmitti*; blue crabs, *Callinectes* sp.; queen conchs, *Strombus gigas*; coquina clams, *Donax denticulata*; and marshclams, *Polymesoda placans*, while industrial-scale fishermen land pink shrimp, *P. notialis*, white shrimp, spiny lobsters, and queen conchs. In the Gulf of Fonseca, a few mollusk species are landed, and extensive shrimp farming is practiced. Mollusks are gathered by hand, and no rakes or dredges are used. The artisanal boats are almost entirely wooden dugout canoes[1], while industrial-scale vessels may be 21–27 m long, constructed of steel or fiberglass; most are made in the State of Louisiana. Fishermen harvest spiny lobsters (Phillips et al., 1994) and queen conchs (Appeldoorn and Rodriguez, 1994) throughout the Caribbean region, but few details depicting gear and methods in Honduras are described in the literature. Previously published articles on Caribbean fisheries for blue crabs, clams, and shrimp are scarce.

We gathered the information for this paper during a survey from 29 February to 13 March 1996 along the north coast, observing and photographing fishing gear and interviewing some 40 government officials, fishermen, managers of fishing co-operatives, gear suppliers, and boat owners. Information regarding mollusks in the Gulf of Fonseca was provided by government officials.

Habitats

The northern Honduras coast, which lies in an east-west direction and is slightly curved, usually is washed by a gentle surf of the Caribbean Sea. The coast has four small, shallow lagoons and one large lagoon. Laguna de Alvarado, Laguna de Los Micos, Laguna de Guaimorte, and Laguna de Brus are 2–17 km across and mostly 0.9–1.2 m deep. Laguna de Los Micos appeared to be closed to the sea in March 1996. The status of another small lagoon, Laguna de Ibans, was not determined. Laguna de Caratasca is located in the Miskitia area in the east and is, by far, the largest lagoon, 50 km long and 11 km wide; it is mostly 2.4–2.7 m deep. Laguna de Caratasca is the largest estuary in Central America. Rivers run into all the lagoons, except Laguna de Alvarado. In early March, surface salinity in Laguna de Brus was 14‰ at its south shore, 18‰ mid-bay, and 32‰ inside the bay opening to the sea, while surface salinity in Laguna de Caratasca was 5.5‰ at the south shore, 9.5‰ in mid-bay, and 4.5‰ at Caukira on its north shore. After a 3-day period of intermittent rains, the salinity was 4.5‰ at the south shore of Laguna de Caratasca. During the rainy season, April–November, the salinity probably is much lower in the lagoons. The lagoons have firm sandy edges, but are mostly muddy in their main regions; waters are turbid.

Lying 27–52 km off the north coast are the Bay Islands: Utila, 14 km long; Roatan, 52 km long; and Guanaja, 17 km long. They are generally surrounded by coral reefs. The tidal range around Roatan Island is 30–35 cm, and water temperatures usually range from 26° to 29°C. About 10 km from the north coast of Honduras are the tiny Cayos Cochinos islands.

The broad shelf extending off northeastern Honduras and Nicaragua is where the principal fisheries for lobsters, shrimp, and conchs are conducted. Lobsters commonly are associated with rocky or spongy bottoms, but can be found on sand and in holes, whereas conchs associate with sandy bottoms commonly with seagrasses. Inshore near Puerto Cortes, artisanal fishermen find lobsters on bottoms having large rocks and trenches. The government considers artisanal fishermen as those who land less than 3 metric tons (t) per year, are independent, with fishing as

[1]Dugout canoes are made of soft, light-weight wood, and they are very buoyant. Paddles are made from the same wood. The canoes last about 15 years if painted and taken out of water when not in use. Small holes in them can be repaired.

Clyde L. MacKenzie, Jr., and Linda L. Stehlik are with the James J. Howard Laboratory, Northeast Fisheries Science Center, National Marine Fisheries Service, NOAA, Highlands, NJ 07732.

ABSTRACT—Honduras has many communities of artisanal fishermen who land various species of crustaceans and mollusks, using hands, nets, traps, and free diving from shore and from dugout canoes. It also has industrial fisheries for spiny lobster, Panulirus argus*; queen conch,* Strombus gigas*; and mainly pink shrimp,* Penaeus notialis*, using traps, scuba divers, and trawl nets.*

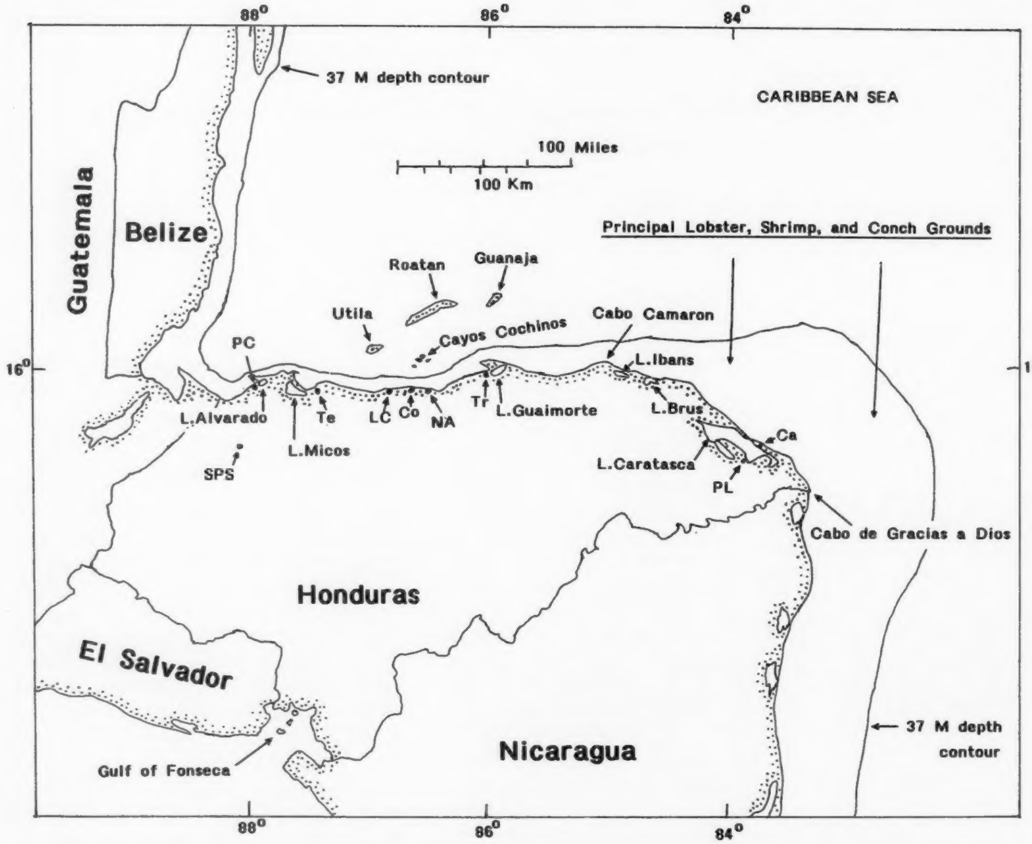

Figure 1.—The Honduras coastline with the lagoons, coastal cities, and villages mentioned in the text. Also included is the approximate 37 m depth contour off the north coast. L. Alvarado = Laguna de Alvarado, SPS = San Pedro Sula, PC = Puerto Cortes, L. Micos = Laguna de Los Micos, Te = Tela, LC = La Ceiba, Co = Corozal, NA = Nueva Armenia, Tr = Trujillo, L. Guaimorte = Laguna de Guaimorte, L. Caratasca = Laguna de Caratasca, L. Ibans = Laguna de Ibans, L. Brus = Laguna de Brus, PL = Puerto Lempira, Ca = Caukira.

their only business. Artisanal fishermen must follow the same regulations and seasons as industrial fishermen.

Honduras Government Administration

The Honduras government sets several regulations to conserve its fisheries, including closed seasons (Table 1). It requires artisanal fishermen to pay a license fee of $1.00/year; licenses for industrial corporations are $10/year. It has set a minimum lobster size: Its tail must measure at least 5.5 inches. No minimum length is set for queen conchs, except where it is 22 cm for those to be exported. The government will confiscate undersized catches.

Historical Molluscan Fishing

Mollusk shells are present in the Mayan ruins located in several places in the country. The shells are of freshwater and marine origin, with the marine shells coming from both the Caribbean and Pacific coasts of Honduras. Most shells are associated with burials, while shells of the Caribbean helmet, *Cassis tuberosa*, were used as horns and musical instruments, and part of the

Table 1.—Numbers of fishing boats and fishermen and landings of fish products in Honduras in 1995. Source: Department of Natural Resources, Tegucigalpa.

Item	Number
Vessels or fishermen	
Lobster trap and dive vessels[1]	200
Shrimp vessels	113
Conch dive vessels	15
Finfish vessels	23
Small artisanal boats	4,855
Artisanal fishermen	5,936
Aquatic production	Landings (t)
Wild shrimp	2,743
Farmed shrimp	9,028
Lobster tails	1,830
Conch meats	291
Finfish	359

[1] Data from J. Rukin, president of fishermen's cooperative, Oak Ridge, Roatan Island.

queen conch shells were used as spoons (Pastor[2]). The Museo De Anthropologia E Historia in San Pedro Sula has a collection of shells from various Honduras Mayan ruins and illustrations of indigenous peoples with shells of *Busycon* and other species (Fig. 2, 3). The shell of the horse conch, *Pleuroploca gigantea*, could be of Honduras Caribbean Sea origin, but those of *Busycon* sp. probably come from Mexico's Gulf of Mexico area.

[2]Teresa Pastor, Director, Museo De Anthropologia E Historia, San Pedro Sula. Personal commun., 1996.

Table 2.—Honduras' closed seasons for crustaceans and conchs.

Species	Months
Lobster[1]	March 16–July 31
Shrimp	February 1–June 30
Queen conch	March 16–August 31

[1] Lobster tails must measure at least 5 inches long.

The authors made several inquiries to people around every lagoon about whether ancient shell middens are present. Few apparently exist as they do on the shores of Bahia de Bluefields in Nicaragua (MacKenzie, In Press).

Fishing for Lobsters and Conchs

Earlier Artisanal Fishing

Before the mid-1980's, artisanal fishermen around the bay islands of Guanaja, Roatan, and Utila used to catch lobsters near shore by free diving without mask or tank. Each carried a stick with a fork at the end to hold a lobster against the bottom before attempting to grab it with a free hand. He then came to the surface (Miller[3]). Another method used more sparingly to catch lobsters at night was to drift across a bottom in water 0.9–1.5 m deep in a dugout canoe holding a torch at the water surface to reflect light from the eyes of a lobster. The fisherman then descended to catch it (Galindo[4]). By free diving, fishermen also caught conchs which were so abundant in places some could be seen from shore in clear waters (Miller[3]). As a consequence of organized industrial fishing in the 1970's and early 1980's, lobsters and conchs became much scarcer in shallow coastal waters (Galindo[4]).

Current Artisanal Fishing

An estimated 50 fishermen from the Bay Islands currently seek lobsters and conchs using only mask and fins. Since fishermen seek mostly lobsters, they dive in shallow rocky areas. A good day's catch for a fisherman is about 5 pounds of lob-

[3]Marston Miller, retired artisanal fisherman, Roatan Island. Personal commun., 1996.

[4]Julio Galindo, Manager, Anthony's Key Resort, Roatan Island. Personal commun., 1996.

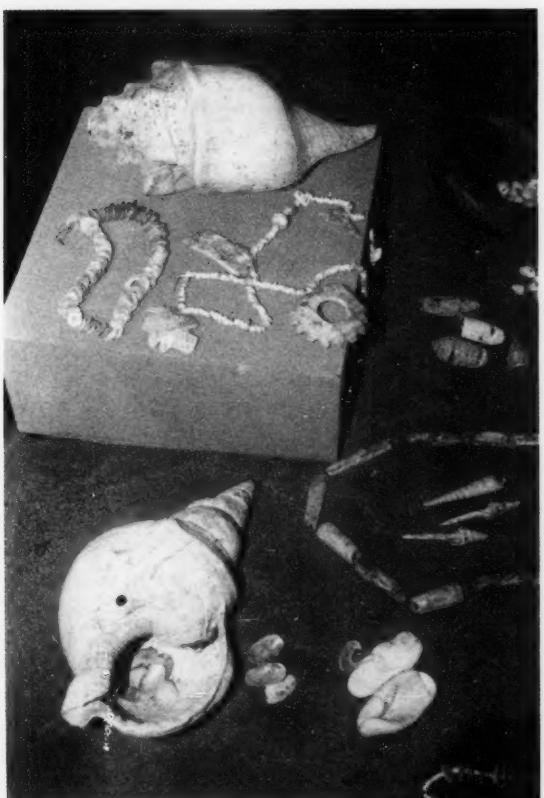

Figure 2.—Part of shell display from Mayan ruins in Museo De Antropologia E Historia in San Pedro Sula.

Figure 3.—Drawing, in the Museo De Antropologia E Historia in San Pedro Sula, of a Mayan in festival costume showing large gastropod shell attached to his arm.

ster tails[5] and 2–3 conchs. Fishermen sell most of the lobsters, but they eat some lobsters and the conchs. Lobster and conch fishing is not allowed on the northwest side of Utila, the north side of Roatan, and the northwest side of Guanaja because the Honduran government has set aside the areas as wildlife refuges, but it is allowed elsewhere (Miller[3]).

Along the north coast of the Honduras mainland from the Puerto Cortes area eastward to villages such as Nueva Armenia, artisanal fishermen catch lobsters in traps and by diving. In Puerto Cortes and nearby villages, about nine fishermen using large dugout canoes with small motors each set from 10 to 150 individually buoyed lobster traps (Fig. 4). Some use small strings of traps weighted at one end with a stone; these are made of wooden slats, have an entrance at the top, measure 75 × 45 × 45 cm, and weigh 50–60 pounds when dry. Set at distances of 2.4–3.7 km from shore at typical depths of 37–46 m on hard sand bottom, they last 3–4 months; mud bottom has few or no lobsters. Traps are baited with cowhide, which costs US$9.50–11.50 for a complete hide, but also with shark or ray hide. Hides are preserved with salt in barrels (Ebanks[6]).

Fishermen setting 150 pots lift 50 pots/day and go with crews of three besides themselves. Three men pull the trap rope through a block while the fourth man steers the boat, propelled by a 30 hp outboard motor. Lobsters are taken from traps with gloved hands or hooks. It takes the crew 2.5–3 hours to lift 50 traps if they do not have to move any to another site (Ebanks[6]). The fisherman with 10 traps gets 8–30 pounds of lobster tails/day. The best lobster catches follow periods of rough weather (Brito[7]).

In the Puerto Cortes area, seven artisanal divers use scuba gear to catch lobsters and conchs. They find lobsters on rocky bottoms at depths of 22–26 m. Two divers go on each canoe, and on their best days may get 20–40 pounds of lobster tails (personal commun.).

The Puerto Cortes fishermen sell most of their lobsters through a cooperative formed in 1995, but some are peddled locally (Fig. 5). This group of fishermen (personal commun.) has sold 5,000 to 10,000 pounds of lobster tails/year.

[5]A whole lobster weighs 2.5 times more than a tail alone.

[6]Carlos Ebanks, artisanal fisherman, Puerto Cortes.

[7]Ramon Brito, secretary, artisanal fisherman's group, Puerto Cortes.

Figure 4.—Spiny lobster traps near Puerto Cortes.

Figure 5.—Sons of a fisherman peddling his catch of spiny lobsters on a roadside near Puerto Cortes.

Figure 6.—Dugout canoes and homes in the village of Nueva Armenia.

In coastal villages eastward of La Ceiba, some fishermen catch lobsters with traps, which they lift every three days, but mostly they go after lobsters and conchs by free diving with a mask and fins. For example, in the Garifuna village of Nueva Armenia (Fig. 6), three fishermen each have 10–50 lobster traps baited with cowhide and also dive for lobsters and conchs; 17 others only dive for them, using dugout canoes with sails. The divers free dive as far as 6 km from shore to depths of 2.7–3.7 m; they used to go farther and dive around the Cayos Cochinos islands, but this is now a reserve where lobster and conch fishing is prohibited. The fishermen can remain underwater about 1 minute. They catch lobsters with a loop of string attached to a stick; a diver puts the loop (Fig. 7) over an antenna of a lobster which is in a defensive position, draws it tightly, swims to the surface trailing the prey, and hands the lobster to the tenderman in his dugout canoe. A diver may get 10–20 lobsters, and, com-

Figure 7.—Artisanal fisherman in Nueva Armenia demonstrating how he places loop of string over an antenna of a spiny lobster under water.

monly, 10–20 conchs/day, but sometimes none (Zuniga[8]).

The artisanal fishermen remove the heads from lobsters when they get ashore. They sell their catches to middlemen who in 1996 paid them US$2.38/pound for lobster tails and US$1.43/pound for conch meat. The middleman sells the meats in the city of La Ceiba and receives US$4.76/pound for lobster tails and US$2.48–2.86/pound for conch meat (Zuniga[8]). Conch meat sold for US$3.43/pound in markets in San Pedro Sula and Tela in March 1996 (personal observ.).

Earlier Industrial Diving

Since at least 1970, commercial diving for lobsters and conchs has been conducted on an industrial scale. In the 1970's and early 1980's, vessels carried 5–10 divers each to areas where depths ran 2.5–12 m. Divers proceeded from the mother vessels in dugout canoes paddled by tendermen and dove with masks and fins but without tanks. When they caught a lobster or conch, they ascended, put it in the canoe, and descended again. In 1976, the divers got 25 centavos/pound for conch meat and 1 lempira/pound for lobster tails; besides, they paid for their own food (Fermin[9]).

Current Industrial Diving

The industrial divers depleted the inshore grounds of lobsters and conchs but, spurred by a strong demand for lobster tails and a consistent demand for conch meat in the United States, the diving fishery for lobsters and conchs expanded substantially when scuba gear was introduced in 1984. This gear allows fishing in much deeper waters. Mother vessels average 23 m long but can be 27 m long (Fig. 8); hired divers are indigenous males from the Miskitia regions of Honduras. Vessels carry 12–24 divers who now begin working as young as 15 years old with most working into their 40's; in 1996, the oldest diver was 56 years old. Each vessel carries 90–100 scuba tanks and an air compressor, and also supplies the masks, regulators, fins, and bags for the divers. It also carries 12–24 dugout canoes[10] (Fig. 9), one for each diver and tenderman; the canoes are owned by the divers. The tendermen are teenagers, who paddle the canoe following bubbles of the diver while he is below. A canoe carries three diving tanks (each filled with 3,000 pounds of air) as well as the lobsters or conch meats the diver has caught (Fermin[9]).

Divers usually harvest at depths of 15–24 m, but range to 37 m in the lobster and conch grounds off the northeastern Honduras coast (Fig. 1). Until the early 1990's, they ranged to 43 m, but too many accidents occurred at depths between 37 and 43 m, and the maximum limit now is set at 37 m (Fermin[9], Martinez[11]).

Since the mid-1980's, the number of divers employed to catch lobsters and conchs from Honduran industrial vessels has increased sharply, currently totalling about 1,800. In addition, there are 1,800 males who help the divers as tenders in the dugout canoes. Roughly 60 vessels, using scuba divers, fish for lobsters, and 15 vessels fish for conchs. In some coastal villages in the Miskitia, a large portion of local males were working on the boats; in the town of Cauquira, with a population of about 3,000 people, 370 were employed as divers in 1996 (Fermin[9], Martinez[11]). The divers (personal commun.) learn their trade by snorkeling as boys and, as teenagers, by working as tendermen.

Operations

During seasons for lobsters and conchs, the vessels make 12 trips/year, each trip lasting 12 days. Between trips, the crews come in for 5 or 6 days to sell the catch and rest. When a vessel is on a lobster or conch ground it is either anchored or adrift, the canoes are pushed into the water, divers and tendermen board them with the gear, and they are paddled off in different directions. The divers put on tank, mask, and fins, take the bag, and enter the water and descend to the bottom to search for lobsters or conchs in the clear Caribbean water. The divers carry a 60 cm handle with a large hook on its end to catch the lobsters (Fig. 10). Lobsters are hooked under the thorax and put in the bag. Lobsters are taken whole, but only the meat of conchs is taken. When going for conchs, the divers carry a chipping hammer with a knife tied onto it (Fig. 11). The hammer is used to crack a hole in the second whorl of the conch's shell, and the knife is inserted to cut the muscle attachment from the shell. The diver pulls out the meat, puts it in his bag, and leaves the shell on the bottom (Fermin[9]). A small quantity of shell is saved on a few vessels to sell to a company in San Pedro Sula, which uses it for making tiles (Galindo[4]). The divers (personal commun.) also collect West Indian topsnails, *Cittarium pica*, to eat aboard their vessels.

After about 45 minutes, air supplies are exhausted, and the divers, after stopping to decompress twice on the ascent, come to the surface with their catches. They may put on another tank of air for a second descent, or return to the mother vessel. Each diver works on the bottom about 4 hours and uses 6–9 tanks/day (Fermin[9]).

When the tenderman and diver return to the mother vessel, they behead the lobsters and weigh the tails. When they are after conchs, they clean the meats and weigh them. In 1–2 dives, a diver gets about 10–12 pounds of lobster tails, 15–20 pounds of conch meats. On extra good days, a diver may get 30–40 pounds of lobster tails, 100–120 pounds of conch meats. The crew on a vessel puts the conch meats in plastic bags holding 40 pounds (Fermin[9]).

The lobster tails and conch meat are frozen aboard the vessels. A large vessel with 24 divers may land 1,500–6,000 pounds of lobster tails, or 15,000–30,000 pounds of conch meat/12-day trip. A vessel with 16 divers can harvest about 10,000 pounds of conch meat; on an extra successful trip, it will land about 15,000 of conch meat (Almendares[12]). The divers are paid

[8]Malaquis Zuniga, artisinal fisherman, Nueva Armenia.

[9]Capil Ulopio Fermin, 20-year industrial diver.

[10]Dugout canoes last only two years when used on diving vessels due to rough handling.

[11]Robinson Alvarez Martinez, secretary, HOMIBAT, Puerto Lempira.

[12]Wilson Almendares, captain of diving vessel *Hy Hopes*, Roatan.

Figure 8.—Mother vessel used for lobster and conch fishing docked in La Ceiba.

Figure 9.—Dugout canoes used by scuba divers piled on stern of mother vessel docked in La Ceiba.

Figure 10.—Divers carry a metal stick with a large shark hook wired onto it to catch lobsters.

Figure 11.—Diver with hammer used to chop hole in second whorl of queen conch and knife used to cut muscle attachment from shell.

according to their catch: 20% of the selling price of lobster tails or conch meat. In 1996, divers received US$1.90/pound for lobster tails and US$0.95/pound for conch meat. Out of this, they pay the tendermen 25% of what they make. Divers may earn from US$1,430–1,900/year; the best make US$3,800–4,800/year (Fermin[9]). The catches are taken to Roatan, where they are repacked in four plants and then sold principally in the United States[13] but also in Honduras. The vessels approach La Ceiba for provisions and then go to the Miskitia area for divers.

HOMIBAT: Divers' Organization

A substantial number of divers have become injured, and some have died during the work. There are no government regulations governing the treatment of divers aboard the vessels. During a 5-year period, 1989–94, when many divers worked at depths between 37 and 43 m, there were 280 diving accidents, nearly all related to decompression sickness or "the bends." In 1995, of the 1,800 working, 70 became sick from "the bends"; 58 were able to return to diving, but 12 were too badly injured to dive again. In addition, four divers died from causes "related to diving" (Martinez[11]).

To improve working conditions, the divers have organized themselves into a formal group called HOMIBAT (Organizacion De Buzos Indigenas Miskitos De Honduras, or organization of indigenous divers in Honduras). HOMIBAT is comprised of nine regions in Belize, Honduras, and Nicaragua, each with a president, and with headquarters in Puerto Lempira. It does not seek government help; rather, it saves money and tries to be self-sufficient in achieving its goals (Martinez[11]).

The goals of HOMIBAT are to lower the accident rate by improving training and capabilities of divers and captains and equipment, food, other living conditions on vessels, and medical treatment. Since 1994, it has 1) brought about an end to diving beyond 37 m, 2) convinced vessel owners to see that divers with bends are taken to the decompression chamber in Roatan as quickly as possible (within 24 hours; in the 1980's, they were often taken there some three days after they got the bends, and some were permanently injured), and 3) convinced vessel owners to provide the divers with tank air pressure and depth gauges (in 1995, 95% of boats had them). In 1995, HOMIBAT was able to hire an instructor to train divers in 1-week classroom sessions about safety; the accident rate has since been lower. In addition, HOMIBAT is trying to increase the incomes of divers by investigating possible markets for sea cucumbers, sea urchins, and starfish,

[13]All products exported from Honduras to the United States are subjected to rigid sanitation requirements.

which the divers often see in abundance while they are searching for lobsters and conchs (Fermin[9], Martinez[11]).

In 1996, there were 30 handicapped divers, 18–50 years old, in the Miskitia. In March 1996, HOMIBAT constructed a building in which ten injured divers at a time will live and construct lobster traps to sell to fishermen. After a period of months, they will be replaced by another group of injured divers. The money generated will be given to the men and their families for support (Fermin[9], Martinez[11]).

Industrial Trapping of Lobsters

An estimated fleet of 140 vessels, 23–27.5 m long, with crews of 10–12 men, sets traps for lobsters on the northwestern shelf of Honduras and northeastern Nicaragua. The vessels obtain licenses from Nicaragua to trap in its waters; few or no Nicaraguan vessels trap lobsters. The Honduran trapping grounds, depths from 15 to 37 m, are where diving for lobsters also takes place. Each vessel works 1,500–2,000 traps on lines of 25 traps each. The traps are baited with cowhide. Using hydraulic haulers, the vessels lift about 500 traps/day during a 7-day week (Rukin[14]).

Each lobster vessel remains on the grounds for 3–4 months at a time, freezing lobster tails in plastic bags as they are caught. Boats from Roatan go out to the vessels regularly to furnish replacement traps that are continuously being made as well as new bait and bring in the lobster tails. A typical vessel catches about 20,000 pounds of lobster tails during the 8-month season, perhaps an average of 100 pounds/day (Rukin[14]).

The lobster trap vessels land substantially more lobsters than the lobster diving vessels. No formal records are available, however, for separate catches of the two types of fishing (Rukin[14]).

Fishing for Blue Crabs

Blue crabs, "jaibas azules" in Spanish, live along the entire northern coast and in various lagoons and river mouths, but not in large numbers. The following species of *Callinectes* occur along the Caribbean coast of Honduras: *sapidus*, *bocourti*, *danae*, *exasperatus*, and *larvatus* (Fischer, 1978). Small commercial fisheries for them exist between Puerto Cortes and Trujillo (Laguna de Guaimorte), but not farther east because no sale exists for them there. They are caught with lift traps (jaiberas), used mostly in depths of 2.4–4.6 m. The traps are baited with fish heads and are individually buoyed (Fig. 12). Fishermen lift one after the other to the surface, shaking out any crabs that have entered them, and dropping them again. Perhaps 20 fishermen, each using 5–30 traps, fish for the crabs along the entire coast and sell them locally. Salable crabs are 9–15 cm wide; 2 or 3 and sometimes 4 make a pound (Morales[15]). In March 1996, packages of 6 crabs sold for US$1.77 in a supermarket in San Pedro Sula.

Few people go after blue crabs eastward of Trujillo. In Laguna de Brus, they get into fishing nets, but fishermen usually toss them back or take a few home to eat. They also catch blue crabs with spears or harpoons (Colindres[16]).

A Japanese firm has constructed a crab picking factory in Caukira on Laguna de Caratasca and in Trujillo, but the Honduras government has been reluctant to give it a permit to catch crabs out of fear that aggressive harvesting will deplete seriously the crab numbers. The company proposes to use Virginia (Chesapeake Bay) style crab traps. They have been tested here with some success (Fermin[9]).

Fishing for Shrimp

Artisanal

The only substantial fishery for shrimp in lagoons was in Laguna de Brus, where fishermen caught white shrimp, *P. schmitti*, with cast nets (Fig. 13). It lasted from early April through June and, if rains were light, sometimes into July. Otherwise, the salinity fell too low and the shrimp left the lagoon. Buy boats, one to four at a time, came into the lagoon to purchase shrimp. When they did, from 200 to 300 men and boys in dugout canoes went after the shrimp with the nets. The water usually was about 0.75 m deep and muddy. Fishermen located concentrations of shrimp by observing them jumping out of water. In 4–5 hours of fishing/day, each got 10–50 pounds of shrimp (weighed without heads). The buy boats sent speed boats around to purchase shrimp from the fishermen after the heads had been removed (Colindres[16]).

In 1995, the fishermen were paid US$0.67/pound for shrimp. The buy

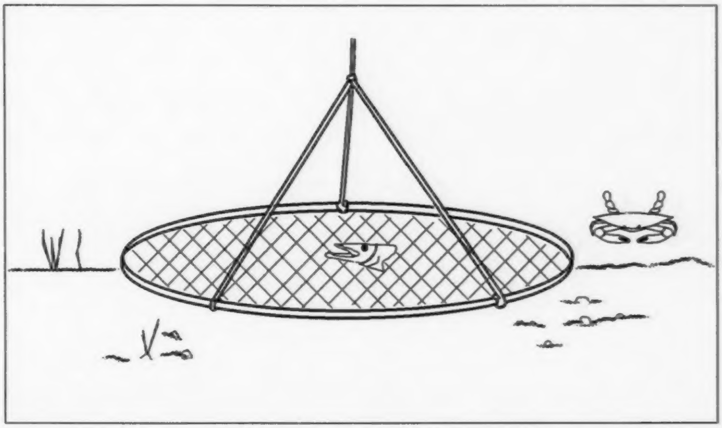

Figure 12.—Lift trap used to catch blue crabs.

[14]James Rukin, president, fishermen's cooperative, Oak Ridge, Roatan Island.

[15]Luis Morales, Honduras Oficina de La Pesca, Tegucigalpa.

[16]Cecilio Colindres, artisanal fisherman, Laguna de Brus.

Figure 13.—Demonstration of cast netting for white shrimp in Laguna de Brus.

boats put them into a cooler, and, after a few days, had a full load which they took to La Ceiba where they were packed for shipment to the United States. The Honduran government banned this spring fishery for shrimp in the Miskitia in December 1995. Besides fishing for shrimp, Laguna de Brus fishermen also went after fish and iguanas (Colindres[16]).

In Laguna de Los Micos, about 10 people seek brown shrimp (unspecified species) with cast nets. The shrimp are sold in nearby Tela (Aguilar[17]). Only minor cast netting for shrimp takes place in other lagoons along the coast (personal commun.).

Industrial

A large fishery for shrimp, mainly pink shrimp, *Penaeus notialis*, exists off the north coast of Honduras, between Cabo Camaron and Cabo de Gracias a Dios, mostly at depths from 18–30 m (Table 1). The shrimp are taken with trawl nets towed at night; the minimum mesh size allowed by law is 3 cm. Some white shrimp are also taken by day by the same boats in shallower waters. The shrimp vessels, based mainly in Roatan, Guanaja, La Ceiba, and one or two other ports, are 21–27 m long and have steel or fiberglass hulls. The two trawl nets they tow have two doors and tickler chains, and, as mandated by the U.S. government, turtle excluder devices (McNab[18]).

The vessels usually make three tows/night, but lift "try nets" regularly to estimate the catch in the large nets. During the main part of the season, vessels can catch as many as 200 pounds of shrimp/lift. At season's end, 10 pounds/lift is common (McNab[18]).

The shrimp boats freeze their catches and remain at sea for several weeks at a time. Boats from packing houses in Roatan periodically go out to the boats to bring in frozen shrimp. They also keep the best finfish and sell them (McNab[18]).

A hazard for the shrimp trawlers are fossil oyster shells located in 18–30 m of water off the Miskitia area (long. 84°–83°W). The trawl nets are torn when they are towed over the shells (Chirinos[19]).

Shrimp Farming

Shrimp farming has boomed around the Gulf of Fonseca in southern Honduras. In 1995, there were 35 medium and large shrimp farms, 15 small projects, and 15 cooperative shrimp farms. The total area devoted to shrimp farming was 11,844 ha, and 5,259 people were engaged on the shrimp farms (ANDAH: National Aquaculture Association of Honduras). Honduran

[17]Victor Agilar, part-time artisanal fisherman, San Juan.

[18]Evans McNab, fishing boat owner, Roatan Island.

[19]Miguel Chirinos, captain, dive vessel *Harmac III*, La Ceiba.

Figure 14.—Children harvesting coquina clams at beach in Corozal.

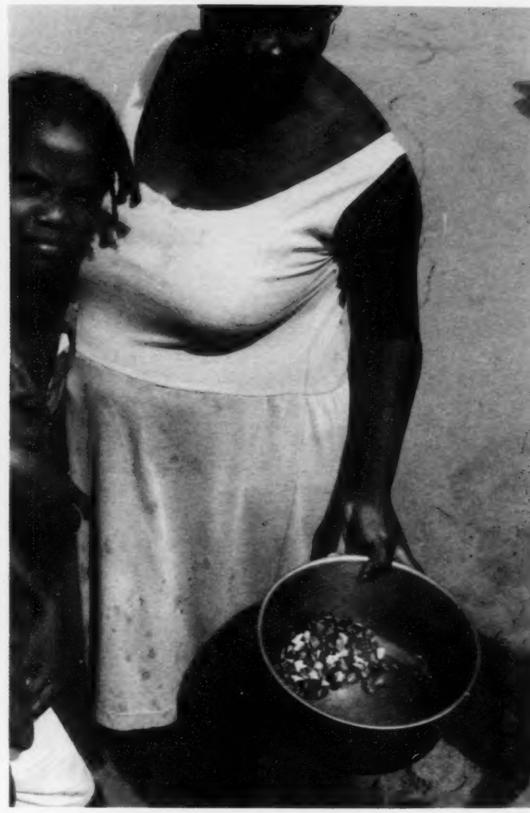

Figure 15.—Partial collection of coquina clams from beach in Corozal.

production of farm-raised shrimp was 3.3 times larger than its production of wild-caught shrimp (Table 1). There are no shrimp farms on the north coast of Honduras (Morales[15]).

Fishing for Coquina Clams

Coquina clams, *Donax denticulatus*, called almejas (Spanish) or ahis (Miskito) locally, are numerous in the surf zone along Caribbean beaches of Honduras. Edible-sized clams, 20–25 mm long, are most abundant in the spring and summer. Local women and children in villages near the shore harvest them once in a while (Fig. 14, 15) to eat at home, usually in soups with rice and coconut milk; alternatively they may be fried with onions. They are never sold in markets (personal commun.).

Fishing for Marshclams

Marshclams, *Polymesoda placans*, mostly called curils (Spanish) or klihto (Miskito) locally, occur in lagoons along the north coast of Honduras, including Laguna de Alvarado, Laguna de los Micos, Laguna de Guaimorte, Laguna de Brus, and Laguna de Caratasca (Aguilar[17], Fermin[9], Luque[20]). People harvest them on only a small scale, even where they are abundant. Most harvesting takes place in Laguna de los Micos where about three people fish for them every day. Using their hands to gather them from the sand substratum in water 30–75 cm deep, each harvests as many as 1,000 marshclams in 5 hours. They are sold locally with the remainder for sale during holidays to restaurants in Tela, where they are served in soups or salads mostly during festivals (Aguilar[17])(Fig. 16). Some marshclams are also used as bait for fish. Marshclams apparently were harvested more extensively in earlier periods.

[20]Jose Luque, hotel owner, Puerto Cortes.

Oysters

Few oysters, *Crassostrea rhizophorae*, occur along the north coast of Honduras. Some grow in Laguna de Guaimorte and along the north shore of Laguna de Brus on mangrove roots. People seek them only occasionally (personal commun.). Oysters are scarce or absent in Laguna de Caratasca, undoubtedly because the salinity is too low. Nueva Armenia fishermen reported they eat crown conchs, *Melongena melongena*, when they find them.

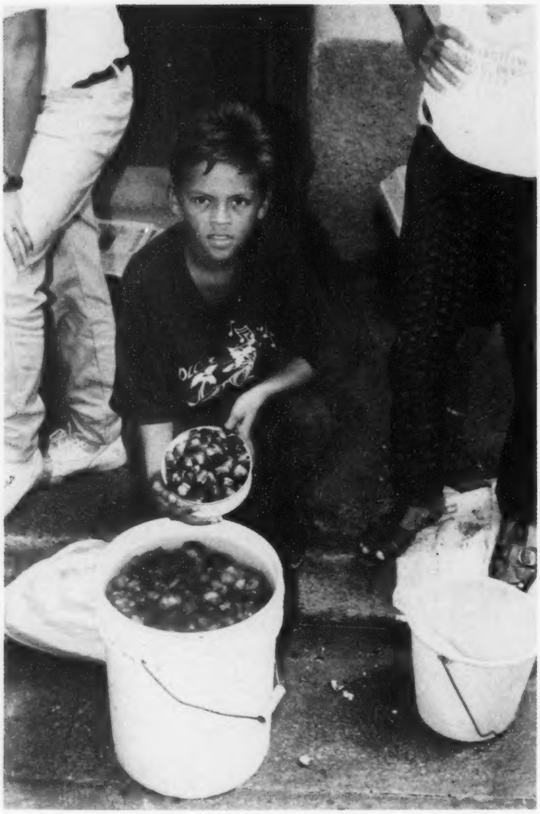

Figure 16.—Peddling marshclams in public market in Tela.

Mollusks in the Gulf of Fonseca

Some mollusks are taken in the Gulf of Fonseca in southern Honduras (Fig. 1). Most are black ark clams, *Anadara tuberculosa*, called "conchas negras" locally; giant ark clams, *A. grandis*, called "casco de burro" locally; beanclams, *Donax dentifer*; and giant eastern Pacific conchs, *Strombus galeatus*. Details on the fisheries for them are unavailable (Portillo[21]).

[21] Milton Portillo, biologist, Oficina de la Pesca, Direccion Regional de Recursos Naturales, San Pedro Sula.

Conclusions

The aquatic habitat in Laguna de Caratasca, Honduras' largest lagoon, is poor for crustaceans and mollusks because the salinity is too low. If the salinity were raised permanently, perhaps above 10‰, larger numbers of white shrimp and oysters, and more marshclams would inhabit the bay. This could be accomplished by making another wide breach in the barrier beach. Marshclams are abundant in various lagoons. Perhaps a larger market could be found for them. Studies need to be made of the abundance, size structure, and productivity of blue crabs so that they can be harvested on a larger scale.

Acknowledgments

We thank many people for providing information verbally. Their names are listed in the footnotes. Special thanks to Milton Portillo and Mario Ruiz, biologists with the Oficina de La Pesca, Direccion Regional de Recursos Naturales, San Pedro Sula, for a guided tour of the Puerto Cortes region and for providing much useful information.

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Editorial Guidelines for the *Marine Fisheries Review*

The *Marine Fisheries Review* publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under a completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgments" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

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In style, the *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 12, "A List of Common and Scientific Names of Fishes from the United States and Canada," fourth edition, 1980. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

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Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

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Title the list of references "Literature Cited" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, and the year, month, volume, and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

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All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8 × 10 inches, sharply focused glossies of strong contrast. Potential cover photos are welcome, but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

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